BERWICK BANK WIND FARM

OFFSHORE ENVIRONMENTAL IMPACT ASSESSMENT

APPENDIX 10.2: MARINE MAMMAL TECHNICAL REPORT

EOR0766
Environmental Impact Assessment – Appendix 10.2
Final

Document Status

Version	Purpose of Document	Authored by	Reviewed by	Approved by	Review Date
FINAL	Final	RPS	RPS	RPS	September 2022

Approval for Issue

Ross Hodson	[Redacted]	9 September 2022

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1. INTRODUCTION

1. This Marine Mammal Technical Report provides a detailed baseline characterisation of the marine mammal ecology for the Berwick Bank Wind Farm offshore components (hereafter referred to as the 'Proposed Development') and surrounding area. Data were collated through a detailed desktop study of the existing resources available for marine mammals within the region, incorporating data from third party organisations, to gain a historical perspective. Recent site-specific survey data from the two years (25 months) of aerial digital surveys which commenced in March 2019 (hereafter referred to as the Digital Aerial Surveys (DAS)) was available to inform the baseline characterisation. Moreover, Sea Mammal Research Unit (SMRU) provided telemetry maps and haul out counts for harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus* and these have been used to inform baseline characterisation (Sinclair, 2022).
2. The aim of this Technical Report is to provide a robust baseline characterisation of the marine mammals likely to be present within the marine mammal study area and against which the potential impacts of the Proposed Development can be assessed.

2. STUDY AREA

3. Marine mammals are spatially and temporally variable, therefore for the purposes of the marine mammal baseline characterisation, two study areas have been defined (Figure 2.1):

    - Proposed Development marine mammal study area: this is an area encompassing the Proposed Development array area and the Proposed Development export cable corridor plus a (approximate) 16 km buffer, including the area to the north and south of the proposed landfall location. This combined area was surveyed by the 2019 to 2021 aerial surveys (Figure 4.3Figure 2.1). It should be noted that the Proposed Development marine mammal study area has been defined based on the Proposed Development array boundaries at the time of the Scoping phase (SSER, 2021a). The Proposed Development array area has been subsequently amended; however, as the refinements resulted in a reduction of the Proposed Development array area, the Proposed Development marine mammal study area is considered to remain representative and conservative for the current assessment. Given that the Proposed Development marine mammal study area has not been realigned to the current Proposed Development boundary, the buffer encompassing the Proposed Development array area may be equal to or greater than 16 km in some locations, including to the north-west, south-west and south-east of the Proposed Development array area.
    - Regional marine mammal study area: marine mammals are highly mobile and may range over large distances and therefore, to provide a wider context, the desktop review considers the marine mammal ecology, distribution and density/abundance within the wider northern North Sea. The boundaries of the northern North Sea are closely aligned with those of Marine Natural Areas (Wildlife Trusts, 2021). The regional marine mammal study area has informed the screening of internationally designated sites and is also the area within which cumulative projects were defined.

4. In accordance with advice received during consultation where population level effects were considered for a given species-impact pathway these were informed by species Management Units (MUs). The Inter-Agency Marine Mammal Working Group (IAMMWG, 2015) provided advice on cetacean MUs and the Special Committee on Seals (SCOS) provided advice on seal MUs (SCOS, 2021). Whilst these MUs provided reference populations for each species it was agreed during consultation that, where MUs for a given species extended over a very large scale (e.g. minke whale *Balaenoptera acutorostrata* and white-beaked dolphin *Lagenorhynchus albirostris* MUs extend over the Celtic and Greater North Sea (CGNS)), the assessment will also consider effects over a smaller scale; within Small Cetacean Abundance in the North Sea (SCANS) III Block R (noting that this is not an ecologically defined area).

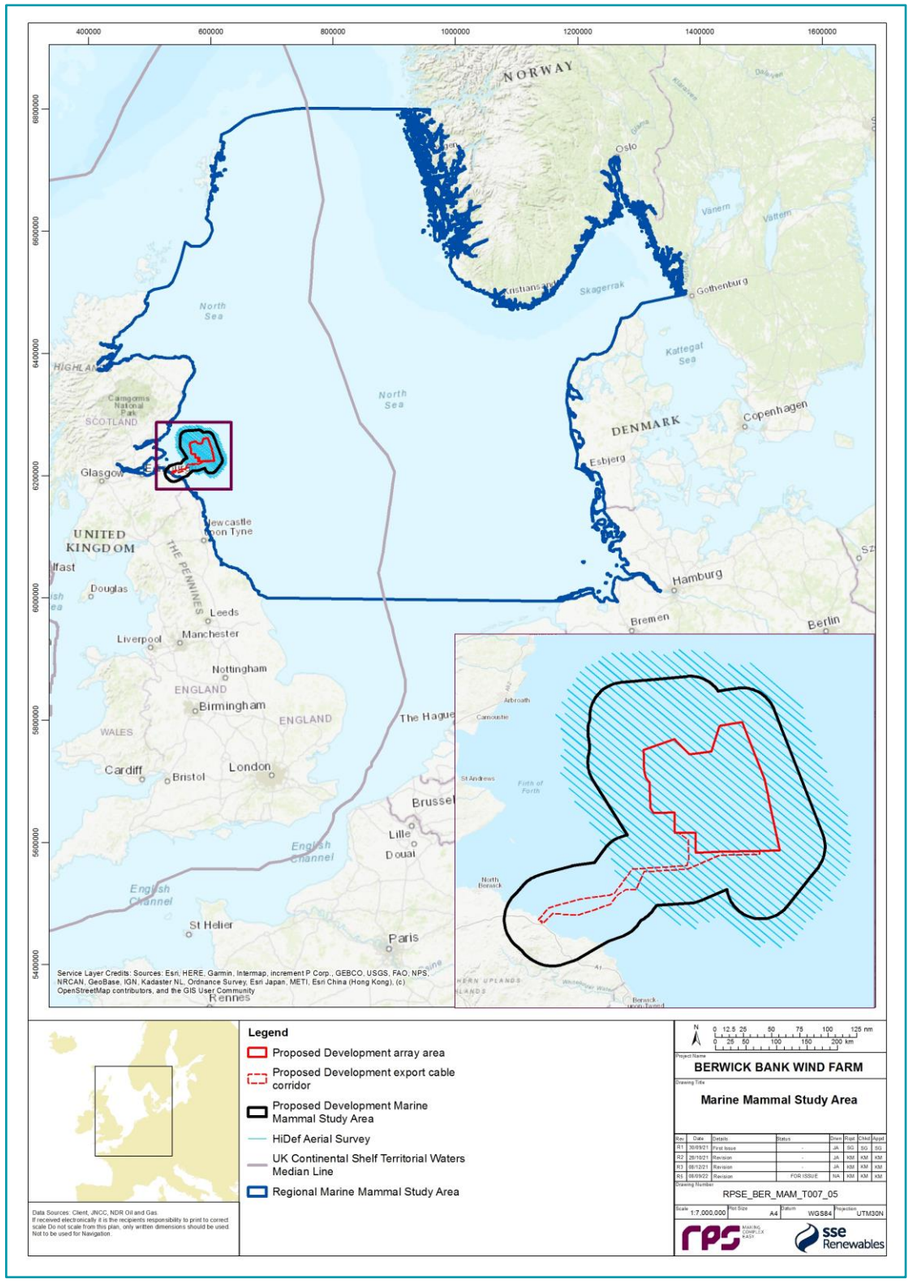

Figure 2.1: Marine Mammal Study Areas

3. CONSULTATION

5. A summary of the key issues raised during consultation activities undertaken to date specific to marine mammals is presented in Table 3.1. Consultation was undertaken with key stakeholders to discuss baseline data sources and any further information sources of relevance.

Table 3.1: Summary of Key Consultation Undertaken of Relevance to Marine Mammal Baseline Characterisation

Consultee	Issues Discussed/Raised
Relevant Consultation Undertaken for 2020 Berwick Bank	
Initial consultation meeting: Marine Scotland - Licensing Operations Team (MS-LOT), Marine Scotland Science (MSS), and NatureScot with respect to 2020 Berwick Bank (18 December 2019)	Discussion of baseline data to include previous boat surveys, SCANS III surveys, The Joint Cetacean Protocol (JCP) Phase III, bottlenose dolphin photo ID from European Offshore Wind Deployment Centre (EOWDC) surveys, SMRU harbour and grey seal at-sea usage and telemetry maps and haul out counts. Additional sightings data may be useful from Neart na Gaoithe offshore wind farm and Sea Watch. Aerial digital survey data will be undertaken over 25 months. MSS suggested that absolute densities may be necessary to allow quantitative assessment of effects.
Pre-Scoping meeting: MSS, MS-LOT, NatureScot with respect to 2020 Berwick Bank (30 June 2020)	Discussion on the study areas to be used in the assessment. Regional marine mammal study areas do not encompass the whole MUs for each species as would be too large to be meaningful. However, MU populations to be used as reference populations.
NatureScot Scoping Opinion in respect to 2020 Berwick Bank (7 October 2020)	Agreement on key species: harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal. Advice provided on relevant reference populations. Advise species-specific MUs to be used as baseline populations and for informing the screening of designated sites. MU abundance estimates have been updated for some cetacean MUs. Advice given on specific MUs to use for each key species. Density surface estimates for harbour porpoise in Scottish waters is based on SCANS-III data. Advice provided on marine mammal densities from published sources upon which to base the assessment.
Berwick Bank Wind Farm Scoping Opinion (MS-LOT, 2022)	MS-LOT advise that the additional sources of information identified in the NatureScot December representation and the MSS December advice must be fully considered by the Developer. The additional data sources to be considered include Hague *et al.* (2020), revised analysis of Heinänen and Skov (2015) harbour porpoise densities to be used instead of original paper and Carter *et al.* (2020) seals at-sea maps as an update from Russell *et al*. (2017). Species in the assessment must be assessed against the whole management unit population and in addition, must be assessed at a regional scale based on SCANS III Block R. The Scottish Ministers direct the Developer to the NatureScot December representation and the MSS December advice on the most appropriate abundance estimate to use for Density estimates that should be sourced from the regional marine mammal baselines report (Hague *et al.*, 2020). Confirmation should be sought on use of the interim Population Consequences of Disturbance model for harbour seal through the Developer's Road Map process.

Consultee	Issues Discussed/Raised
MS-LOT Scoping Opinion for 2020 Berwick Bank (MS-LOT, 2021)	Species specific MUs must be used as the baseline reference for cetaceans' population. Advice regarding datasets used to inform the baseline. The density values for all the key species require further discussion.
Consultation on the Proposed Development	
Road Map Meeting 1: NatureScot, MS-LOT, MSS for the Proposed Development (24 August 2021)	Regional marine mammal study area boundaries were discussed with NatureScot representatives. The agreement is that assessment of population-level impacts (baseline population) will be focused on MUs on a species-specific basis and where MU is too large, assessment will look at relevant SCANS-III Block (Block R). MSS noting that this is not a biologically relevant area. Key species to take forward to assessment were agreed by all consultees. Use of correction factors to account for availability bias during aerial digital surveys. Tagging data is likely to be the best option for understanding dive profiles. MSS recommendation to use Carter *et al. (*2020) maps for seals as long as they could be corrected to provide absolute densities. MSS suggested at-sea maps may be more suitable than aerial digital data due to problems of identifying to species-level. MSS recommendation to use ECOMMAS data to predict densities of bottlenose dolphin in coastal (inshore) areas.
Road Map Meeting 2: NatureScot, MS-LOT, MSS for the Proposed Development (20 October 2021)	Regional marine mammal study area boundaries were discussed with specific reference to cumulative assessment. No issues raised by consultees. Bottlenose dolphin densities should be based on the 5-year weighted average population for the east coast of Scotland (Arso Civil *et al.,* 2021) and the proportional occurrence of bottlenose dolphins at stations recorded along the east coast (ECOMMAS data). Approach and methodology were provided to consultees for review on 27/10/2021. Suggested that data from Newcastle University were sourced to check range of bottlenose dolphin (i.e. movements along north-east coast of England). MU populations for white-beaked dolphin and minke whale are currently being reviewed by SNCBs and will be updated following interagency meeting (IAMMWG) at the end of October 2021. The approach to combining grey seal and 'seal species' sightings from aerial digital data to derive density estimates for grey seal needs justification. Stakeholders are in favour of using published at-sea density maps (Carter *et al*., 2020) vs recent site-specific data for the assessment.

Consultee	Issues Discussed/Raised
NatureScot EIA Scoping Advice (7 December 2021)	The North Sea region is a large area, therefore NatureScot recommend the use of the Firth of Forth area for the Isle of May, and the Firth of Forth plus the Farne Islands for Berwickshire and North Northumberland Coast (see SCOS, 2020). This latter site crosses the border between Scotland and England and needs to be considered in the assessment. Carter *et al*. (2020) habitat preference maps should be used for the prediction of the at sea seal abundance and distribution. As per clarification received from NatureScot on 17 March 2022, the assessment of impacts for grey seal is based on at-sea maps (Carter et al., 2020) for non-breeding populations and JNCC standard data forms for breeding populations. Natural England has been consulted on the appropriate SACs and potential impacts to be taken forward for consideration of likely significant effects (LSE) in the Report to inform Appropriate Assessment (RIAA) (SSER, 2022c).
NatureScot and MSS joint response to estimating bottlenose dolphin densities (21 December 2021)	Stakeholders agree with the approach to use a density of 0.197 animals per km^2 between the 2 to 20 m bathymetric contours, from Peterhead to the Farne Islands and a density of 0.294 animals per km^2 for the outer Firth of Tay using the Arso Civil *et al.* (2019) probabilities of occurrence.
Road Map Meeting 3: NatureScot, MS-LOT, MSS in relation to the Proposed Development (18 January 2022)	NatureScot raised queries with regard to grey seal densities used for this assessment, suggesting that at-sea seal usage maps from Carter *et al.* (2020) would be more appropriate than site-specific survey data to calculate the surface densities and take forward to the assessment of effects. NatureScot reiterated that the most up-to-date bottlenose dolphin population estimate for Coastal East Scotland MU is 224 individuals, based on 5-year weighted average from Arso Civil *et al.* (2021) instead of the MU population from Cheney *et al.* (2013), which was previously recommended by consultees.
Berwick Bank Wind Farm Scoping Opinion (MS-LOT, 2022)	MS-LOT advise that additional sources of information identified in the NatureScot December representation and the MSS December advice must be fully considered. MS-LOT highlights the NatureScot's December 2021 representation and the MSS December 2021 advice with regard to the use of IAMMWG (2021). MS-LOT directs the Developer to the NatureScot December representation and the MSS December advice on the most appropriate abundance estimate to use for the assessment. In relation to the distribution of bottlenose dolphins, the Scottish Ministers refer to the MSS December advice to use two different distributions of density to account for the range expansion and habitat preferences of the east coast dolphin population. With regard to NatureScot's recommendation to use the Carter *et al.* (2020) habitat preference maps for the prediction of the at sea seal abundance and distribution, the Scottish Ministers highlight the concerns raised in the MSS December advice in relation to using the current scalars. MSS have requested advice on the use of these scalars and in the meantime have advised the scalars should be used with caution, noting they may require to be updated. MS-LOT stated that they are content with the preliminary screening of the Southern Trench ncMPA (nature conservation Marine Protected Area) and confirm the site can now be screened out. The Scottish Ministers are content that no further marine mammal ncMPAs are to be included.

4. METHODOLOGY

4.1. DESKTOP STUDY

4.1.1. REGIONAL DATA SOURCES

6. Information on marine mammals within the regional marine mammal study area was collected through a detailed desktop review of existing studies and datasets. These are summarised at Table 4.1.

Table 4.1: Key Sources of Information for the Marine Mammal Baseline Characterisation

Title	Survey/Data Years	Author
Bottlenose dolphin Photo ID surveys and SAC site condition monitoring	May-Sept 2009 to present	Quick *et al.* (2014); Cheney *et al.* (2013); Arso Civil *et al.* (2019) and Cheney *et al.* (2018)
East Coast Marine Mammal Acoustic Study (ECOMMAS) Passive Acoustic Monitoring (PAM) data	2013 to present	MSS
Marine Ecosystems Research Program cetacean density surfaces	1980 to 2018	Waggitt *et al.* (2020)
Seal haul-out counts	1996-2019	Sinclair (2022) (Annex B)
Seal telemetry	1990 to 2018	Sinclair (2022) (Annex B)
Small Cetaceans in European Atlantic Waters (SCANS) III	Jul 2016	Hammond *et al.* (2021)
SCANS II	Jul 2005	Hammond *et al.* (2006)
Seal at-sea usage	Telemetry: 114 grey seals and 239 harbour seals Count: 2015-2020	Russell *et al.* (2017) Carter *et al.* (2020)
Forth and Tay Offshore Wind Developers Group cetacean survey data analysis report	2009 to 2011	Mackenzie *et al.* (2012) King and Sparling (2012)
Joint Nature Conservation Committee (JNCC) Report 544: Harbour Porpoise Density	1994 to 2011	Heinänen and Skov (2015)
Analysis of The Crown Estate (TCE) aerial survey data for marine mammals for the Forth and Tay Offshore Wind Developers Group (FTOWDG)	1994 to 2011	Grellier and Lacey (2011)
Joint Cetacean Protocol Phase III	1994 to 2010	Paxton *et al.* (2016)
Cetacean Baseline Characterisation for the Firth of Tay: Bottlenose dolphins	PhotoID: 2009 and 2010 PAM: 2006 to 2009	Quick and Cheney (2011)
Regional Baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters	2020 report on MUs for marine mammals	Hague *et al.* (2020)

4.2. SURVEYS

7. A number of surveys have been conducted over the Proposed Development. This section provides an overview of each of these surveys with a summary given in Table 4.2.

Table 4.2: Summary of Survey Data

Title	Extent of survey	Overview of Survey	Survey Contractor	Date	Reference to Further Information
TCE Aerial Survey	Firth of Forth and Tay, Scottish Territorial Waters	Aerial digital survey	WWT Consulting	May 2009 to March 2010	Grellier and Lacey (2011) Macleod and Sparling (2011)
Seagreen Firth of Forth Round 3	Firth of Forth Round 3 Zone	Visual boat-based survey	ECON Energy	May 2009 to November 2011	Sparling (2012)
Seagreen Boat-Based Surveys	Firth of Forth Round 3 Zone plus 2 km buffer	Visual boat-based survey	Unknown	May to August 2017	Seagreen (2018)
Digital Aerial Surveys	Proposed Development array area plus ~16 km buffer	Aerial digital survey	HiDef	March 2019 to April 2021	Aerial Data Report (Annex A)

4.2.1. TCE AERIAL SURVEYS FOR THE FORTH AND TAY OFFSHORE WIND DEVELOPERS GROUP (FTOWDG) REGION (HISTORICAL)

8. Visual aerial surveys of the Scottish territorial waters (within 12 nm) and Firth of Forth and Tay Round 3 sites were commissioned by TCE (Grellier and Lacey, 2011). The transect design was based on parallel lines with equal spacing in both inshore (up to 12 nm) and offshore (greater than 12 nm) areas (Macleod and Sparling, 2011). Surveys were carried out during 24 days between May and August 2009 (summer) and November 2009 and March 2010 (winter) (Figure 4.1). Between five and 48 sections of transects were flown in any one survey day and observed track length varied from 341 km to 1,116 km.

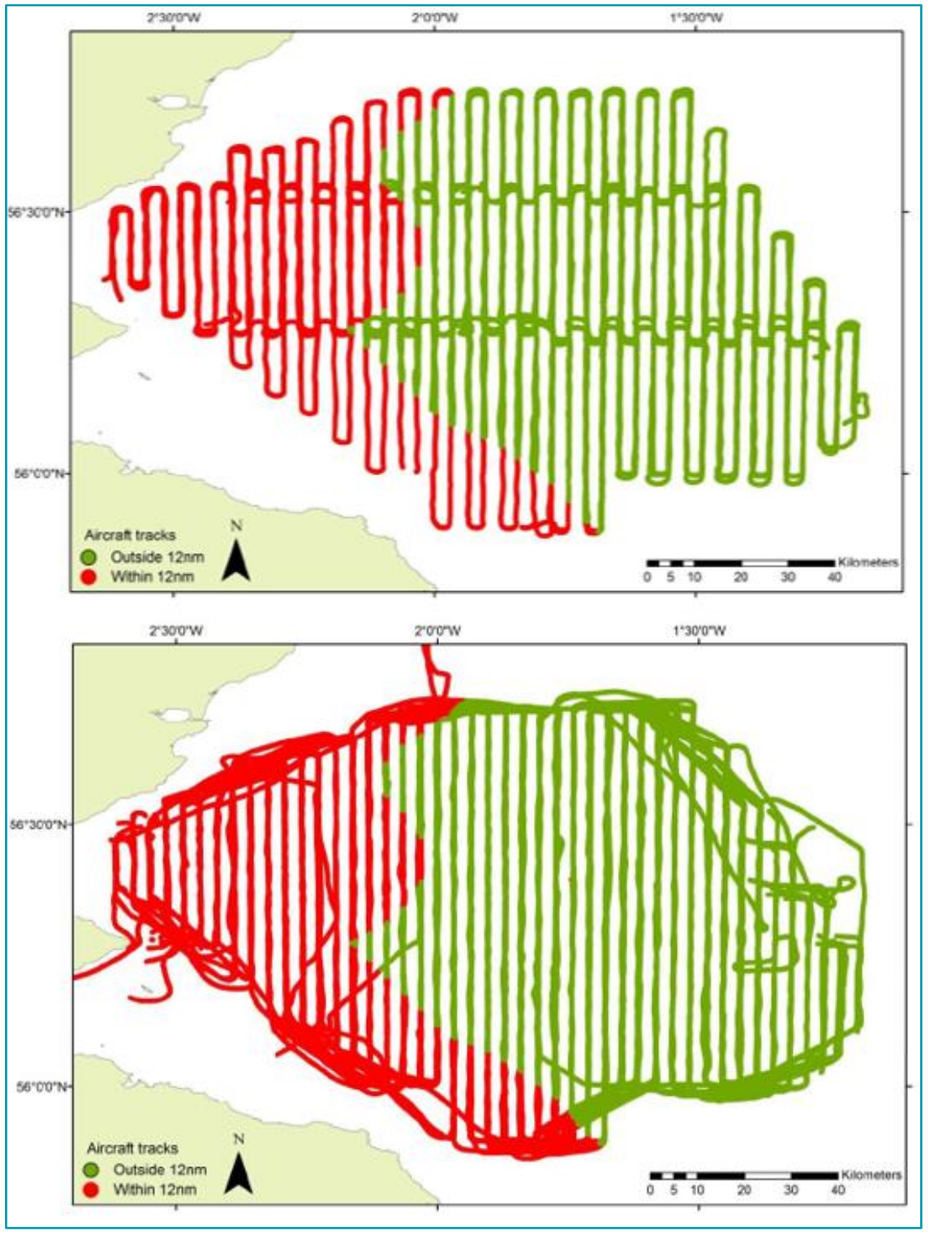

Figure 4.1: Summer (Top) and Winter (Bottom) Survey Tracks Flown Within and Beyond the 12 nm Boundary in May to August 2009 and November 2009 to March 2010 (Source: Macleod and Sparling (2011))

4.2.2. SEAGREEN FIRTH OF FORTH ROUND 3 BOAT-BASED SURVEYS (HISTORICAL)

Visual boat-based surveys for marine mammals and seabirds, undertaken to inform the Environmental Impact Assessments (EIAs) for Seagreen Wind Energy Limited (hereafter referred to as Seagreen) were carried out by ECON Energy. The survey area comprised the Firth of Forth Round 3 Zone, which is approximately 2,850 km^2 and its boundary lies approximately 25 km offshore of the Firth of Forth. Encounter rates and distribution of sightings of marine mammals from the 19 surveys which took place between May 2010 and November 2011 were analysed and reported by SMRU Ltd (Sparling, 2012). The survey was carried out each month and followed transect lines distributed 3.7 km apart across four different routes (east, west, north and south), spaced at 300 m from each other (Figure 4.2). The four routes were rotated with each route used once per season (i.e. every four months) to maximize coverage of the zone. Over the 19 surveys, a total of 17,017 km of survey effort was conducted. Data were analysed by DMP Statistical Solutions UK Limited using a model-based approach to estimate densities and abundances of key species (harbour porpoise *Phocoena phocoena*, white-beaked dolphin and minke whale) within the survey area (Mackenzie *et al.,* 2012).

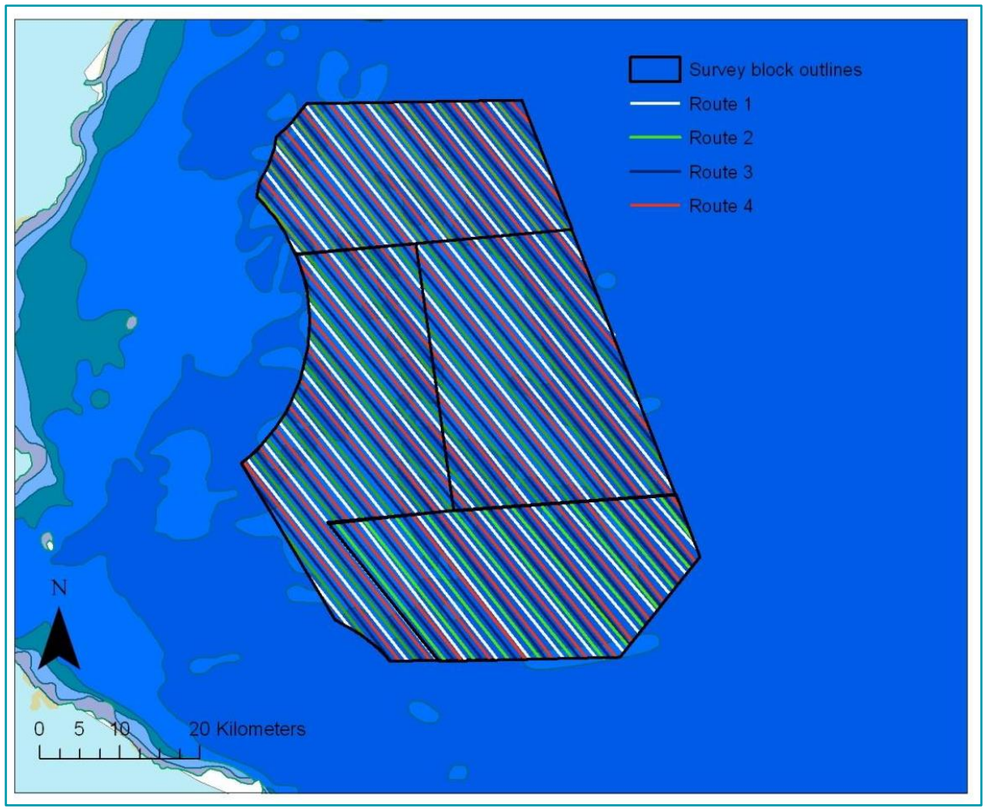

Figure 4.2: Seagreen Firth of Forth Round 3 Survey Area (Source: Sparling (2012))

4.2.3. SEAGREEN BOAT BASED SURVEYS (HISTORICAL)

9. Surveys for birds only were undertaken for what was previously known as the Seagreen Alpha/Bravo project area (and known since 2018 as 'Seagreen') in summer 2017 (May to August inclusive). Incidental recordings of marine mammal presence were recorded during these surveys (hereafter 'the Seagreen boat-based surveys'), where sea state ranged between one (excellent) and four (average). A summary of the marine mammal incidental sightings was reported in the Seagreen Marine Mammal Baseline Technical Report (Seagreen, 2018).

4.2.4. DIGITAL AERIAL SURVEYS (2019 TO 2021)

Survey approach

10. Aerial digital surveys of seabirds and marine mammals commenced in March 2019 and continued monthly until April 2021 with an additional survey undertaken in May 2020 and April 2021 to cover delayed surveys in April 2019 and April 2020. The surveys were conducted by HiDef from an aircraft equipped with four HiDef Gen II cameras with a set resolution of 2 cm ground sample distance (GSD) and at an altitude of 550 m above sea level (ASL). The transects followed the routes shown in Figure 4.3, flying at an operational speed of 220 km per hour (equivalent to 120 knots). Position data for the aircraft were recorded using a Garmin Global Positioning System (GPS) Map 296 receiver with differential GPS to give 1 m accuracy and allowed recording updates at one second intervals to match to bird and marine mammal observations.

11. A total of 37 transects were spaced 2 km apart across the aerial survey area, which encompasses the Proposed Development array area plus a ~16 km buffer area (hereafter referred to as 'aerial survey area'). The aerial survey area covered a total area of 4,980 km^2 (Figure 4.3). Transects were flown to cover a total length of approximately 2,490 km each month, and data from two cameras (0.25 km combined width) were subsampled to provide a minimum target of 10.0% coverage of the total survey area and an optimum coverage of 12.5% of the total survey area (approximately 620 km^2 each month). Table 3.1 in Annex A presents details of the survey effort across the survey area.

12. Data from these surveys have been used to provide current information on species presence, distribution and abundance/densities within the survey area. Full details of the survey methodology, data processing and data analyses are provided in Annex A.

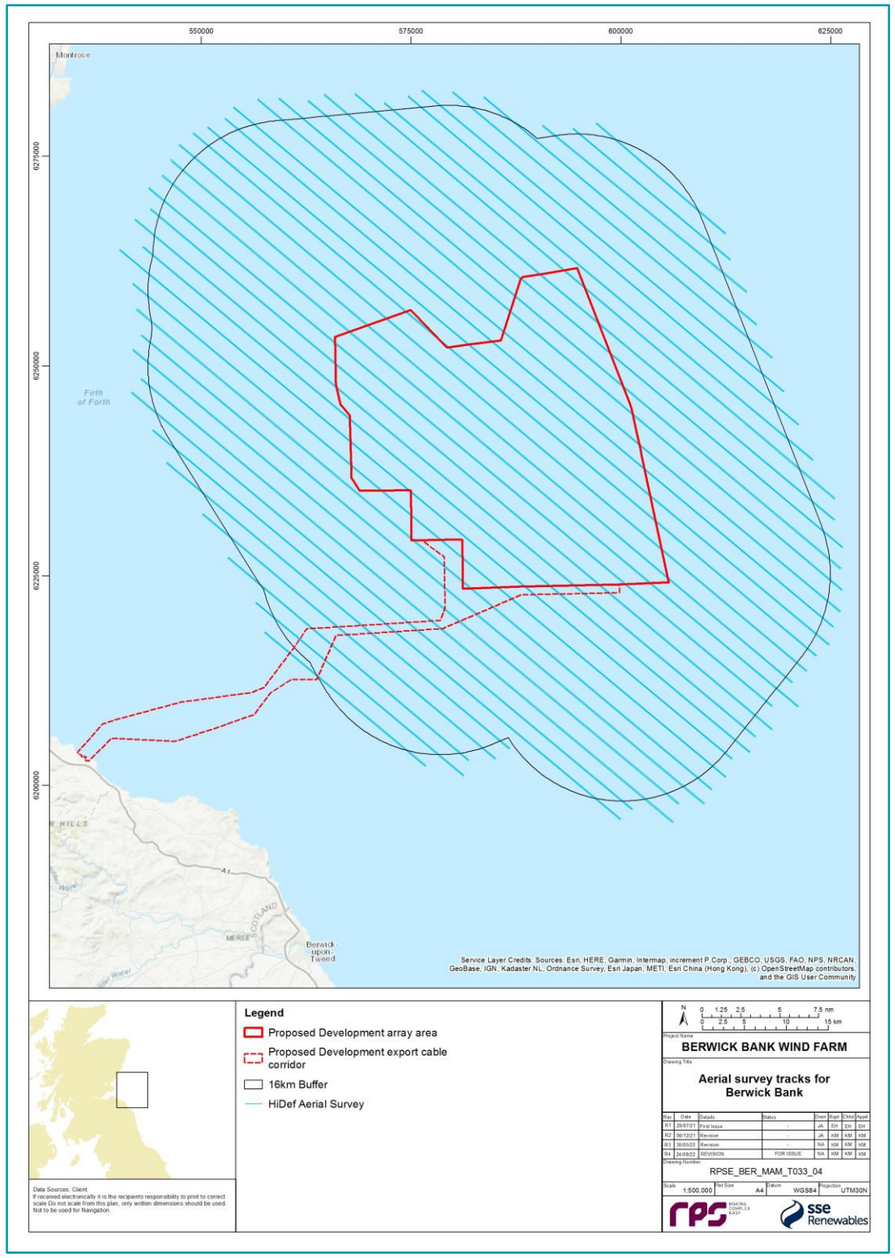

Figure 4.3: Strip Transects at 2 km Spacing for Digital Aerial Surveys Across the Proposed Development Aerial Survey Area (March 2019 to April 2021)

4.3. ASSUMPTIONS AND LIMITATIONS

4.3.1. MARINE MAMMAL OBSERVERS

13. Boat-based surveys rely on marine mammal observers to record number of marine mammals and accurately identify the individuals to the species level. Ideally, a survey team, following a standard distance sampling approach, should consist of one observer to monitor the track line, a second to monitor over distance and a third person as a scribe. The team would then be rotated to reduce the possibility of observer fatigue. The historical boat surveys (Sparling, 2012) adopted the use of only a single marine mammal observer which could potentially lead to under recording. The potential for under-recording was not an issue with the DAS as all observations within the transect strip length were recorded.

4.3.2. SURVEY TRACKS

14. The historical boat-based survey data (Sparling, 2012) supplied for analysis of the marine mammal data included the start and end points for each transect covered on a given day. Positions of some sightings across the surveys suggested that the boat had deviated from a straight line (designed tracks) on occasion. Since the effort is calculated as the distance over the straight line between start and end points, it may result in a slight underestimate of the length of the survey compared to actual boat tracks and therefore a slight overestimate of encounter rates.

15. During the DAS, there were some months when not all transects could be flown (e.g. due to technical issues or weather conditions). When this was the case, remedial action was taken to improve the effort by analysing data from additional cameras along those transects nearest to the ones that had been missed.

4.3.3. WEATHER CONDITIONS

16. Boat based surveys are typically carried out for collecting bird and marine mammal data simultaneously. Seabird surveys are generally carried out in sea states of up to four, whilst marine mammals are surveyed only in in sea states of up to three. Therefore, it is possible that encounter rates may be biased downwards if portions of the survey were carried out in sea states above three. Harbour porpoise in particularly are difficult to record and sea states of up to two are often recommended.

17. Sea state is less problematic for aerial surveys and surveys can effectively be carried out in sea states of up to four for both marine mammals and birds (HiDef, pers comm).

4.3.4. BIAS IN DATA

18. Availability bias (where an animal is underwater and therefore not available for detection) is corrected for using an estimate of the probability that an animal is on the surface at any randomly chosen instant. The resulting correction factor is then used to estimate the total number of animals that may be present within the survey area. In the case of aerial digital surveys, animals are available for detection if they are on the surface or just below the surface (depth of detectability is dependent on water clarity).

19. Perception bias (where an animal is on the surface but the detection is missed) is less of a limiting factor since the high definition video aerial survey captures all animals on the surface and the detection is not influenced by the ability of an observer to detect an animal.

20. The data from all surveys provided a count of the relative numbers of each species (or species group) within the transects, however, there were no site-specific data on availability bias from any of the surveys. Therefore, published correction factors, where considered to be appropriate, were applied to data to correct for bias in data to approximate absolute numbers. Correction factors were applied to the Proposed Development aerial digital survey data and are described in Annex A.

21. Some species are known to actively avoid vessels of any kind, either by moving away or by diving, introducing unquantifiable bias into the data collected during boat-based surveys (Palka and Hammond, 2001). It is also troublesome to record wide ranging or cryptic species, especially when making the snapshot count.

4.3.5. SPECIES INDENTIFICATION

22. During both historical aerial (Grellier and Lacey, 2011) and boat-based (Sparling, 2012) surveys, identification to species level can be challenging, especially when an individual is submerged. On the aerial shots collected during aerial surveys only part of the animal was above the surface and on some occasions, it was not possible to distinguish between species. In the case of DAS (Annex A), given the prevalence of grey seal in this area, all unidentified seals were classed as grey seals. Similarly, unidentified cetaceans were assigned to harbour porpoise. This may lead to overestimated numbers of most abundant species and underestimation of species which were not identified.

4.3.6. SURVEY TIMINGS

23. The aerial surveys for Firth of Forth and Firth of Tay were collected across two seasons between May 2009 and March 2010 (summer and winter) on 24 days only. The boat-based data for the Seagreen Firth of Forth Round 3 were collected on a monthly basis between May 2010 and November 2011. These data are now more than ten years old and it is possible that there may have been changes in the distribution and abundance of marine mammals in the vicinity of the Proposed Development.

24. DAS have been conducted monthly between March 2019 and April 2021. Due to constraints outwith the control of Hi-Def, the April surveys were delayed (April 2019 and April 2020) and therefore two surveys were undertaken in May 2020; one in early May (05 May 2020) and one later in May (16 May 2020) (see section 2.5 in Annex A). It represents a snapshot over a single survey day on each month (except May 2020 as two days were covered). This survey method was agreed with stakeholders and despite it having some limitations, it is a standard practice to collect data on a single day throughout the two-year time span. Changes in sightings rates may be influenced by environmental conditions, however it has not been possible to explore this over short time frame (one day) of data collection. Therefore, whilst differences in sighting rates between months may be due to seasonal changes, environmental conditions also have the potential to influence these results.

4.4. OTHER STUDIES AND DATA SOURCES

4.4.1. SMALL CETACEANS IN THE EUROPEAN ATLANTIC AND NORTH SEA (SCANS) SURVEYS

25. The main objective of SCANS surveys was to estimate small cetacean abundance and density in the North Sea and European Atlantic continental shelf waters. The SCANS I surveys were completed in 1994, SCANS II in July 2005 and SCANS III in July 2016 and all comprised of a combination of vessel and aerial surveys. Both aerial and boat-based survey methodologies were designed to correct for availability and detection bias and allow the estimation of absolute abundance.

26. The Proposed Development is located in the SCANS II survey area V and SCANS III survey area R, surveyed by boat and air respectively. The ship surveys in SCANS II covered a total transect length of 3,022 km and an area of 160,517 km^2 (Burt *et al*., 2006). In 2016 the SCANS III aerial survey total search

effort was 51,286.7 km and covered the surface area of 1,208,744 km^2 (Hammond *et al*., 2021). The original SCANS III data was published in the Hammond *et al.* (2017) report, which has been revised following the discovery of some analytical errors and the updated version Hammond *et al.* (2021) is used for the purpose of this study.

4.4.2. JOINT CETACEAN PROTOCOL (JCP) PHASE III ANALYSIS

27. The JCP Phase III analysis included 38 data sources with data from at least 542 distinct survey platforms (ships and aircraft) conducted to estimate spatio-temporal patterns of abundance of seven species of cetacean over a 17-year period (1994 to 2010) over a 1.09 million km^2 prediction region from 48° N to c. 64° N and from the continental shelf edge west of Ireland to the Kattegat in the east.

28. Species of cetaceans included in the study are harbour porpoise, minke whale, bottlenose dolphin *Tursiops truncatus*, short-beaked common dolphin *Delphinus delphis*, Risso's dolphin *Grampus griseus*, white-beaked dolphin and Atlantic white-sided dolphin *Lagenorhynchus acutus*. Density surface models were used to predict species density over a fine scale grid of 25 km^2 resolution for one day in each season in each survey year. The data are divided into regions for which seasonal estimates of abundance for winter (January to March), spring (April to June), summer (July to September) and autumn (October to December). The Proposed Development is situated within the "Firth of Forth area of commercial interest", covering the area of 14,241 km^2.

4.4.3. JNCC REPORT 544: HARBOUR PORPOISE DENSITY

29. Heinänen and Skov (2015) conducted a detailed analysis of 18 years of survey data on harbour porpoise around the United Kingdom (UK) between 1994 and 2011 held in the JCP database. The goal of this analysis was to try to identify "discrete and persistent areas of high density" that might be considered important for harbour porpoise with the ultimate goal of determining Special Areas of Conservation (SACs) for the species. The approach involved constructing predictive models using corrected sightings rates analysed with respect to topographic, hydrodynamic and anthropogenic covariates and then generating predicted distribution maps of density estimates for the waters around the UK. The analysis grouped data into three subsets: 1994 to 1999, 2000 to 2005 and 2006 to 2011 to account for patchy survey effort and analysed summer (April to September) and winter (October to March) data separately to explore whether distribution patterns were different between seasons.

30. Due to the uneven survey effort over the modelled period, there was a large degree of uncertainty in modelled distributions. Additionally, the analysis presented in Heinänen and Skov (2015) relied on extensive extrapolation of survey data over space and time. Any such extrapolation is sensitive to the covariates used in models and makes the assumption that these relationships hold outside of the surveyed areas.

4.4.4. SPECIAL COMMITTEE ON SEALS (SCOS)

31. Under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) provides scientific advice to government on matters related to the management of seal populations through the advice provided by the SCOS. SMRU provides this advice to SCOS on an annual basis through meetings and an annual report. The report includes advice on matters related to the management of seal populations, including general information on British seals, information on their current status, and addresses specific questions raised by regulators and stakeholders. The most recent publicly available SCOS report is SCOS (2020) which presents the data collected up to 2019.

4.4.5. SMRU SEAL SURVEYS

32. SMRU carries out surveys of harbour and grey seals in Scotland and on the east coast of England to contribute to the NERC's statutory obligation under the Conservation of Seals Act 1970 through provision of scientific advice on matters related to the management of seal populations to the UK Government. SMRU surveys, as well as surveys by a number of other organisations (including NatureScot, Natural England, the Countryside Council for Wales, the National Trust and the Lincolnshire Wildlife Trust) form the routine monitoring of seal populations around the UK.

33. Seals are widely distributed around the UK coast and most surveys are carried out from the air by either light aircraft or helicopter. All surveys are of seals that are hauled out on shore. On account of differences in the breeding behaviour of harbour and grey seals, the two species are surveyed at different times in their annual cycle.

34. A SMRU report was commissioned to support the baseline assessment for the Proposed Development. The report provided a detailed account of grey and harbour haul outs within the vicinity of the Proposed Development based on recent surveys (Annex B). A brief account of the survey methods for each seal species is provided in the following sections.

Harbour seals

35. Surveys of harbour seals are carried out during the summer and early autumn months. There are two types of surveys conducted: breeding counts and moult counts.

Harbour seal breeding counts

36. Breeding seals are surveyed in June and July in a small number of areas. Breeding season surveys are carried out annually in the Moray Firth and, in recent years, in Lincolnshire and Norfolk. A very limited number of breeding season surveys have been carried out on behalf of NatureScot in areas designated as SACs for harbour seals in Scottish waters and there were no breeding surveys carried out for the colonies in the vicinity of the Proposed Development marine mammal study area. Therefore, no data was available for haul out sites considered within this report.

Harbour seal August moult counts

37. The main population surveys are carried out when harbour seals are hauled out onshore to moult, during the first three weeks of August. To maximise the numbers of seals onshore and to reduce the effects of environmental variables, surveys are restricted to within two hours either side of afternoon low tides on days with no rain.

38. Harbour seals inhabiting rocky shores are surveyed during the moult using a helicopter equipped with a thermal imaging camera that can detect seals on land at a distance of up to 3 km. Seals on sandbanks in the east coast estuaries (including annual counts of the Firth of Tay and Eden Estuary SAC) are usually surveyed from a fixed wing light aircraft using conventional, oblique photography.

39. The moult counts obtained represent the number of harbour seals that were onshore at the time of the survey and are an estimate of the minimum size of the population. They do not represent the total size of the local population since a proportion of the population would have been at sea at the time of the survey.

Grey seals

40. Grey seals aggregate in the autumn to breed at traditional colonies. Their distribution during the breeding season is very different to their distribution at other times of the year.

41. Grey seals are surveyed during their breeding season (August to December). Most breeding colonies are surveyed by SMRU by fixed wing aerial vertical photography (Hebrides, Orkney, north Scotland the north-east Scotland, and most of the Firth of Forth) while others are surveyed by ground count by other organisations (Shetland, Inchcolm in the Firth of Forth and England). The last major survey for which data has been processed and is available is 2016, where 67 colonies were counted. The most recent complete grey seal pup production survey (covering Orkney, Inner and Outer Hebrides and the North Sea colonies) was conducted in 2019. However, data from these surveys have not been processed at the time of writing and so have not been included in this report.

42. Grey seals are also counted during SMRU's harbour seal August moult surveys. However, counts of grey seals during the summer months can be highly variable and, although these counts are not used as a population index, they provide useful information on the summer and non-breeding season distribution of grey seals.

4.4.6. DESIGNATED SEAL HAUL OUT SITES

43. In Scotland, seals are protected under the Marine (Scotland) Act 2010. Section 6 of this Act prohibits the taking of seals except under licence. Licences can be granted for the protection of fisheries and aquaculture and for scientific and welfare reasons. The NERC, through the SCOS and the NERC sponsored SMRU, provides advice on all licence applications and haul-out designations. Section 6 of this Act also prohibits harassment and injury to seals. The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014 laid in the Scottish Parliament on 26 June 2014 which, from 30 September 2014, makes it an offence to harass seals at these sites. Harassment involves any activity that pesters, torments, troubles or attacks a seal on a designated haul-out site. In particular, it would include any action that causes a significant proportion of seals on a haul-out site to leave that site either more than once or repeatedly or, in the worst cases, to abandon it permanently (Marine Scotland, 2014a; 2014b).

44. Within or in the vicinity of the Proposed Development marine mammal study area there are two seal haul out sites (Kinghorn Rocks and Inchmickery and Cow and Calves) and three grey seal breeding colony sites (Fast Castle, Inchkeith and Craigleith) designated under this order (see Figure 6.17 and Figure 6.24 for harbour and grey seal respectively).

4.4.7. SEAL TELEMETRY DATA

45. SMRU has deployed telemetry tags on grey seals and harbour seals in the UK since 1988 and 2001, respectively. The telemetry tags transmit data on seal locations with the tag duration (number of days) varying between individual deployments. Telemetry data are particularly useful as they provide information on seal movement patterns away from their haul out sites, provide data on the foraging behaviour of seals at sea and demonstrate connectivity between areas.

46. There are data from two types of telemetry tag, which differ by their data transmission methods. Data transmission can be through the Argos satellite system (Argos tags) or GPS phone tags which combine GPS quality locations with transmission of data using the Global System for Mobile communication (GSM) phone network. These methods are described in more detail in section 2.2 of Annex B.

47. Telemetry data presented in this report draws on the SMRU commissioned study (Sinclair, 2022), which presents an analysis of existing satellite data to describe the movements of harbour and grey seal within or in the vicinity of the Proposed Development marine mammal study area (Annex B).

4.4.8. SEAL USAGE MAPS

48. Carter *et al.* (2020) have produced revised estimated at-sea distribution usage maps for both grey and harbour seals based on habitat association modelling. The previous usage maps (Russell *et al.,* 2017) contained telemetry data from 270 grey seals and 330 harbour seals tagged within the UK only and incorporate count data between 1996 and 2015. Carter *et al. (*2020) maps incorporated an additional 100 GPS telemetry tags deployed on grey seals at sites where recent tracking data were lacking. The at sea usage maps represent the number of grey and harbour seals estimated to be in the water in each 5 km x 5 km grid cell at any given time. Values in the Carter *et al.* (2020) report are presented as spatial predictions of relative density. For the purpose of this report, absolute densities were calculated based on the total at-sea population size for British Isles presented in Appendix 2 of Carter *et al.* (2020). However, there are concerns about accuracy of scalars used for the analysis (Russell *et al.,* 2016; Lonergan *et al.,* 2013). Therefore, the scalar to convert haul-out counts to the total population and the scalar to convert the total population to the at-sea abundance are currently being reviewed. Given the above, results of the analysis of densities presented in Carter *et al.* (2020) are to be taken as approximate estimates, rather than definitive numbers.

4.4.9. THE EAST COAST MARINE MAMMAL ACOUSTIC STUDY (ECOMMAS)

49. The ECOMMAS began in 2013 and involved 30 PAM sites along the east coast of Scotland to collect data on the relative abundance of dolphins and porpoises. Every PAM site contained a C-POD capable of detecting dolphin and porpoise echolocation clicks and some sites also contained an acoustic recorder (SM2M) capable of recording underwater noise and the vocalisations of dolphin species.

50. There were 15 locations along the Scottish east coast outside of the Moray Firth including three C-POD stations at each of the following locations: Cruden Bay, Stonehaven, Arbroath, St Andrews and St Abbs. Each location had PAM units placed approximately 5 km, 10 km and 15 km from the coast (Figure 6.11).

51. Data from these surveys was analysed, however due to it is limitations, only the main findings are presented to inform the baseline (described further in section 6.1.2).

5. BASELINE ENVIRONMENT

5.1. LEGISLATION AND CONSERVATION DESIGNATIONS

5.1.1. LEGAL FRAMEWORK

52. In Scottish inshore waters (within 12 nm of the coast), the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) make it an offence to disturb a cetacean intentionally or recklessly. The Marine (Scotland) Act 2010 provides improved protection for seals. Moreover, The Marine (Scotland) Act 2010 and The UK Marine and Coastal Access Act 2009 includes provisions to designate Marine Protected Areas (MPAs) (within territorial and offshore waters respectively. In the UK, all species of marine mammals up to 12 nm are protected under the Wildlife and Countryside Act (1981). Additionally, in Scotland basking shark *Cetorhinus maximus* is given full protection under Schedule 5 of the Wildlife and Countryside Act 1981. Basking shark have been considered in more detail as a part of desktop study in section 4.2.1 of volume 3, appendix 9.1.

53. A number of marine mammal species are listed in Annex II of the Habitats Directive (Council Directive 92/43/EEC) as species whose conservation requires the designation of SACs. In Scotland, Annex II marine

mammal species for which SACs are designated include harbour porpoise, grey seal, harbour seal and bottlenose dolphin.

54. Under Annex IV of the Habitats Directive, all cetacean species are afforded strict protection wherever they occur within a Member State's territory, both inside and outside designated protected areas. These are termed European Protected Species (EPS).

55. MPAs (also called Nature Conservation MPAs) are areas of the sea with special controls to protect species and habitats, and to support the wider marine ecosystem. A total of 35 MPAs have been designated in Scotland's seas (NatureScot, 2021c). The development of this network has been progressed between Marine Scotland, JNCC, Natural England, Historic Environment Scotland (HES), Scottish Environment Protection Agency (SEPA) and NatureScot, along with a range of marine stakeholders.

5.1.2. CONSERVATION DESIGNATIONS

56. A number of designated areas within the northern North Sea (i.e. regional marine mammal study area) have marine mammals as notified interest features (Figure 5.1). Information to support a Habitats Regulation Appraisal (HRA) screening was provided for the whole of the regional marine mammal study area to determine the European sites that should be considered further in the RIAA (SSER, 2022c). In this Technical Report we present an overview of European sites that fall within the UK portion of the regional marine mammal study area or are within the central part of the northern North Sea and therefore more likely to have connectivity with the Proposed Development (as opposed to sites near to the European coastline, approximately 500 km or more from the Proposed Development). A summary of the relevant marine mammal qualifying interest and/or protected features for each site is provided in Table 5.1.

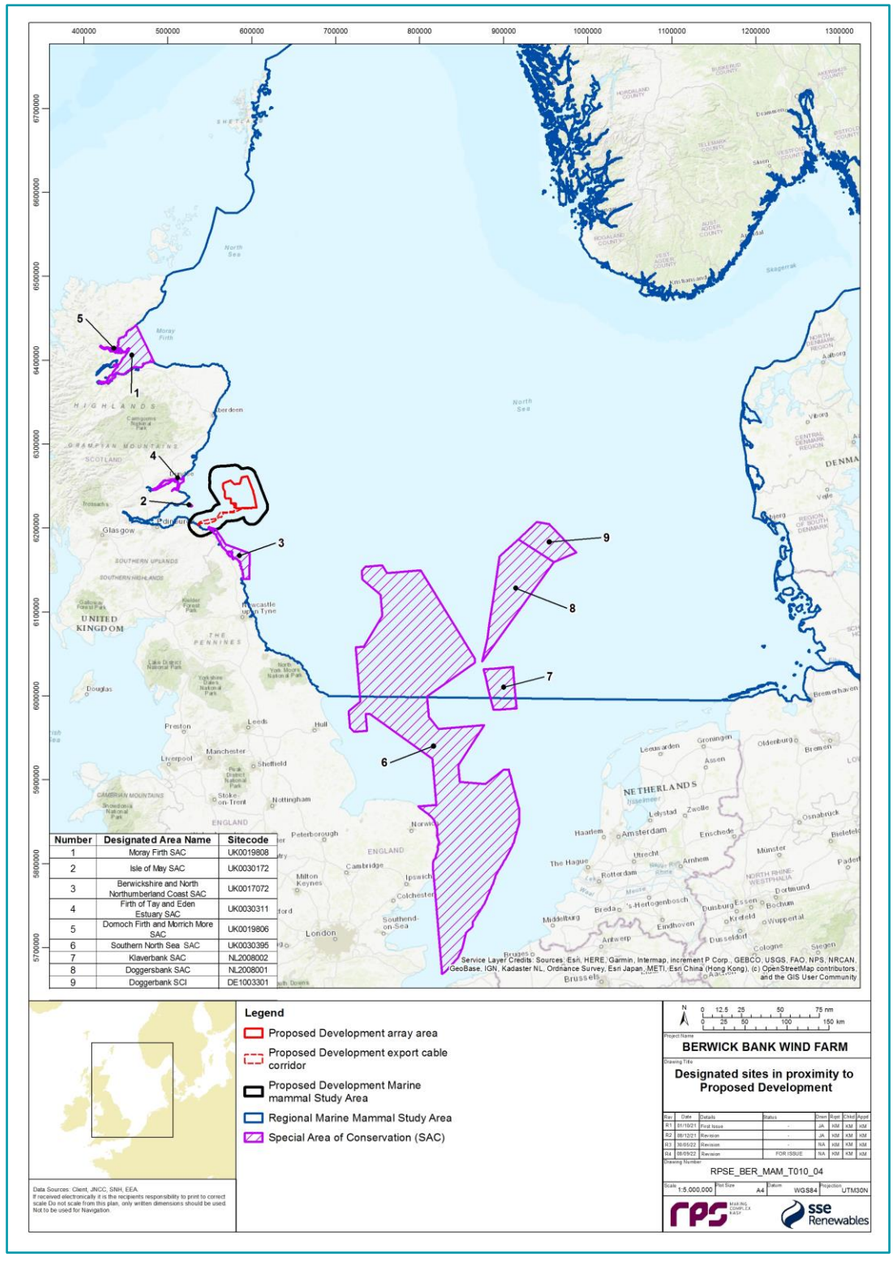

Figure 5.1: European Sites Designated for Protection of Marine Mammals Within the Regional Marine Mammal Study Area

Table 5.1: SACs Designated for the Protection of Marine Mammals within the Regional Marine Mammal Study Area

Site name	Distance from Proposed Development Array Area (km)	Distance from Proposed Development Export Cable Corridor (km)	Marine Mammal Interest Feature	Administrative Region
Berwickshire and North Northumberland Coast SAC	35	4	Grey seals	England/Scotland
Isle of May SAC	40	21	Grey seals	Scotland
Firth of Tay and Eden Estuary SAC	47	45	Harbour Seals	Scotland
Moray Firth SAC	167	193	Bottlenose dolphins	Scotland
Dornoch Firth and Morrich More SAC	195	221	Harbour seals	Scotland
Southern North Sea SAC	146	151	Harbour porpoise	England
Doggersbank SAC	295	301	Harbour porpoise	Netherlands
Doggerbank Site of Community Importance (SCI)	314	320	Harbour porpoise	Germany
Klaverbank SAC	332	336	Harbour porpoise	Netherlands

Berwickshire and North Northumberland Coast SAC

57. Extending over an area of 652 km^2, the Berwickshire and North Northumberland Coast SAC lies approximately 35 km from the Proposed Development array area (English Nature, 2005). This site features a range of Annex I habitats, including mudflats and sandflats not covered by seawater at low tide, large shallow inlets and bays, reefs as well as submerged and partially submerged sea caves (English Nature, 2005).

58. The SAC embodies an extensive and diverse stretch of coastline in south-east Scotland and north-east England. The latter coastal section provides important habitats for Annex II grey seal species. The breeding colonies within this SAC consist of approximately 1,000 individuals and support around 2.5% of UK pup production (JNCC, 2015a).

Isle of May SAC

59. The Isle of May SAC extends over an area of 3.5 km^2 (JNCC, 2015b) and is located approximately 40 km from the Proposed Development array area. It is located at the entrance to the Firth of Forth on the east coast of Scotland and supports Annex II species, the fourth largest breeding group of grey seals in the British Isles (contributes approximately 4.5% annual UK pup production) (JNCC, 2015b). The SAC is the largest east coast breeding colony of grey seals in Scotland and comprises of up to 5,900 individuals. The annual SCOS reports suggest that the population of grey seals within this SAC is increasing (e.g. SCOS, 2019; SCOS, 2020).

Firth of Tay and Eden Estuary SAC

60. The Firth of Tay and Eden Estuary SAC lies approximately 47 km from the Proposed Development array area, covers an area of approximately 155 km^2 and comprises of two high quality estuarine areas, which are integral components of a large, geomorphologically complex area (JNCC, 2021a). The SAC supports a breeding colony of harbour seal. From 2002 to 2017 the harbour seal count for the Firth of Tay and Eden Estuary SAC decreased rapidly at approximately 18.6% p.a. (see annex B). Subsequently, the count in 2019 for this SAC was 41 individuals, which represents a 95% decrease from the mean counts recorded between 1990 and 2002 (SCOS, 2020). Sporadic counts in the Firth of Forth indicate, however, that the decline is localised within the SAC and may not represent the trends in the overall MU population. Adults use sandbanks within this SAC as a haul out habitat to rest, pup and moult (JNCC, 2021a). Other species utilizing the SAC area include grey seal, harbour porpoise and bottlenose dolphin.

Moray Firth SAC

61. The Moray Firth SAC is located approximately 167 km to the north of the Proposed Development array area and supports the only known resident population of bottlenose dolphin in the North Sea (Annex II species). This SAC covers an area of 1,512 km^2 and extends from the inner firths to Helmsdale on the north coast and Lossiemouth on the south coast (JNCC, 2021b). The bottlenose dolphins found in the Moray Firth SAC are part of a Scottish east coast population of 224 animals that ranges south past Aberdeen to the Firths of Tay and Forth (Quick *et al.,* 2014; Arso Civil *et al.,* 2021). Data from the site condition monitoring suggest that the proportion of the east coast of Scotland bottlenose dolphin population that use the SAC has declined, although the overall population along the coast is increasing (Cheney *et al.,* 2018) and it is thought that their range is extending (Quick *et al.,* 2014; Cheney *et al.,* 2018; Arso Civil *et al.,* 2019; Arso Civil *et al.,* 2021).

62. Other marine mammals observed regularly within this SAC include harbour porpoise, grey seal and harbour seal. The population of harbour seal consist of 501 to 1,000 individuals that occur throughout the year, breeding and resting on intertidal sandbanks in the inner Moray First and making regular foraging trips into the central and outer Moray Firth (Bailey *et al.,* 2014).

Dornoch Firth and Morrich More SAC

63. The Dornoch Firth and Morrich More SAC covers an area of approximately 87 km^2 (JNCC, 2015c) and lies approximately 195 km from the Proposed Development array area. The features of interest include a variety of marine features including reefs, sublittoral sandbanks and estuaries. It is located at the most northerly estuary in Britain and supports a significant proportion of the internationally important population of harbour seal (accounts for almost 2% of the UK population). This is also the most northerly population of harbour seal which utilise sandbanks as haul-out and breeding sites (JNCC, 2015c).

Southern North Sea SAC

64. The Southern North Sea SAC, covering an area of 36,951 km^2, was designated to conserve harbour porpoise (JNCC, 2021c). The majority of the site lies offshore (88%), extending into English inshore waters (12%) and it is located 146 km to the south-east from the Proposed Development array area. Population estimates within the site based on the 2016 survey are a minimum of 20,237 (lower 95% CI) and a maximum of 41,538 individuals (JNCC, 2019) The SAC area supports an estimated 17.5% of the UK North Sea MU population. The northern part supports higher densities of porpoises during the summer season (April to September), whilst the southern part is recognised as an important area during the winter season (October to March) (JNCC, 2021c).

Doggersbank SAC

65. The Doggerbank SAC is located approximately 295 km from the Proposed Development array area and lies within Dutch waters encompassing an area of 4,735 km^2 (EUNIS, 2021a). The site became a SAC in

2016. Qualifying species for the site include harbour porpoise, grey and harbour seal (EUNIS, 2021a). Conservation objectives are to maintain the distribution, extent and quality of habitat for the purposes of maintaining the population and maintain the extent and quality of habitat in order to maintain the population (BEIS, 2021).

Doggerbank Site of Community Importance

66. The Doggerbank SCI is located in German waters, approximately 314 km from the Proposed Development array area and covers an area of 1,699 km^2 (EUNIS, 2021b). Qualifying species for the site include harbour porpoise and harbour seal (EUNIS, 2021b). Conservation objectives of the site are to maintain and restore to favourable conservation status qualifying species and their habitats, and maintain and restore the site's specific ecological functions, biodiversity and natural hydrodynamics and morphodynamics (BEIS, 2021).

Klaverbank SAC

67. The Dutch Klaverbank (Cleaver Bank in English) is located approximately 332 km from the Proposed Development array area. It extends over 1,539 km^2 in a transboundary area shared between the UK and the Netherlands (Álvarez *et al.,* 2019). Grey seal, harbour seal, and harbour porpoise are all qualifying interest features of this site, but it is also known to host minke whales and white-beaked dolphin during summer months (Álvarez *et al.,* 2019). The population size of the qualifying species has not been identified. Conservation objectives are to maintain the distribution, extent and quality of habitat for the purposes of maintaining the population and maintain the extent and quality of habitat in order to maintain the population (BEIS, 2021). Studies suggested that little is known about the Dutch North Sea grey seal population because, albeit most seals spend the majority of their time close to their central place, they travel large distances along the continental coast and to/from the UK (Brasseur *et al.,* 2010). There are estimated to be approximately 1,700 grey seals in the Dutch North Sea (Noordzeeloket, 2021a). During historical aerial survey, a high density of grey seal was observed in the Klaverbank SCI (the site was designated as SAC in June 2016), particularly to the north of the site (Deerenberg *et al.,* 2010).

68. The harbour seal is the most abundant seal species in the Netherlands, with an estimated 6,000 individuals inhabiting the Dutch section of the North Sea and Wadden Sea (Noordzeeloket, 2021b). In the Klaverbank SAC, a harbour seal density of 0.46 to 0.6 animals per km^2 were observed (Deerenberg *et al*., 2010).

69. The harbour porpoise occurs regularly in Dutch waters, either alone or in small groups. There has been an increase in sightings in this area since 1990; the current population estimate in Dutch waters lies between 15,000 and 19,000 individuals. During historical aerial survey, a harbour porpoise density of 0.46 to 0.6 individuals per km^2 were recorded within majority of the site. However, to the north of the site, a higher density was estimated (1.06 to 1.25 individuals per km^2) (Deerenberg *et al*., 2010).Overview of Marine Mammals

5.1.3. REGIONAL MARINE MAMMAL STUDY AREA

70. The northern portion of the North Sea is an important area for cetaceans, with both numbers and species diversity decreasing towards the south (Weir, 2001). It regularly supports 11 species of cetaceans and two species of pinnipeds (Weir, 2001; Hammond *et al.,* 2013; Hammond *et al.,* 2021; NMPI, 2021). The distribution of marine mammals is strongly influenced by the distribution of their prey. Higher abundance of cetaceans in the north may be correlated with presence of pelagic species, which enter the North Sea via northern area adjacent to deep Atlantic waters along the continental shelf edge (Weir, 2001). The occurrence of cetacean species is often unpredictable due to their highly mobile nature. Although the distribution of marine mammals in the North Sea is patchy, some areas consistently hold a higher number of species.

71. The east coast of Scotland and north-east of England support multiple haul-out sites for both grey seal and harbour seal and densities of these species might be expected to be higher in the vicinity of these areas at certain times of the year (Hammond *et al.,* 2002; Weir, 2001).

72. Within the coastal waters of the east of Scotland, the more commonly recorded cetaceans include harbour porpoise, bottlenose dolphin, white-beaked dolphin, and minke whale. Other species of cetacean have been recorded as occasional or rare visitors to this region (Table 5.2).

Table 5.2: Summary of Cetacean Species Found in the Regional Marine Mammal Study Area. Sources: Weir (2001), Hammond *et al.* (2013), Hammond *et al.* (2021) and NMPI (2021)

Species	Occurrence in the Northern North Sea	Description
Toothed Whales, Dolphins and Porpoises		
Harbour porpoise	Abundant	Abundant and widespread throughout the northern North Sea and is the most frequently reported cetacean in the North Sea
Bottlenose dolphin	Common	Occurs throughout the northern North Sea. The Moray Firth supports the only known remaining resident population in the North Sea
White-beaked dolphin	Abundant	Abundant and widespread throughout the northern North Sea and is the second most frequently reported cetacean in the North Sea
Atlantic white-sided dolphin	Occasional	Occurs typically in deep waters along continental shelf although regularly enters the North Sea over summer months.
Short-beaked common dolphin	Rare	Occasionally sighted along the east coast of the UK and is mostly associated with warmer waters to the south and west of the UK
Killer whale *Orcinus orca*	Occasional	Largely distributed in the northern North Sea but most sightings are from around the Shetland Isles or the Norwegian coast.
Risso's dolphin	Occasional	Widely distributed around the Northern Isles; sightings along the east coast of the UK are rare.
Long-finned pilot whale *Globicephala melas*	Rare	Rarely recorded off the continental shelf edge and is mainly distributed in the colder waters of the North Atlantic
Beaked Whales		
Sowerby's beaked whale *Mesoplodon bidens*	Rare	Associated with deep water off the shelf edge to the north and west of Scotland and is rarely recorded in the northern North Sea
Baleen Whales		
Minke whale	Common	Ranges widely and can be observed throughout the northern North Sea
Fin whale	Rare	More typical of the deep waters to the north and west of Scotland rather than the North Sea, small numbers reported in the northern North Sea

5.1.4. PROPOSED DEVELOPMENT MARINE MAMMAL STUDY AREA

73. Data from surveys conducted within the Firth of Forth (Table 4.2) demonstrate that several marine mammal species occurred regularly within the Proposed Development marine mammal study area. Harbour porpoise was the most frequently recorded cetacean during the aerial and boat-based surveys and was recorded in every month of the year. Other species recorded during the surveys within the Proposed Development marine mammal study area included minke whale and white-beaked dolphin (both with seasonal occurrence during spring/summer months), grey seal (year-round) and harbour seal (only three sightings recorded to species level). Only a small number of bottlenose dolphin were observed during DAS (two sightings with a total of seven individuals); however, the Proposed Development marine mammal study area is situated in close proximity to the east coast of Scotland population range for this species and

therefore their presence within the Proposed Development marine mammal study area could not be precluded.

5.2. PROPOSED DEVELOPMENT AERIAL DIGITAL SURVEY DATA ANALYSIS

74. This section refers to DAS undertaken by HiDef, across the aerial survey area. The aerial digital surveys commenced in March 2019 and were undertaken monthly, with a total of 25 months of data collected up until April 2021.

5.2.1. MARINE MAMMAL COUNTS

75. Six species of marine mammals were identified during the DAS (Table 5.3). Of the cetaceans, harbour porpoise was the most frequently recorded species and was sighted in every month of the year. Minke whale and white beaked dolphin were seasonally sighted with most observations between the months of May to September each year. Bottlenose dolphin were sighted in only two months over the 25 months of survey: October 2019 (one individual) and April 2021 (group of six individuals).

76. Seals were typically difficult to identify to species level from the aerial survey data. Grey seals were recorded in each month, with the exception of March 2021. Similarly, 'seal species' were recorded in each month, with the exception of February 2020. Only three sightings of harbour seal were made over the 25 months of survey with one individual recorded in each of January, February and April 2021. It is therefore considered likely that the majority of 'seal species' will be grey seal.

Table 5.3: Monthly Raw Sightings Data (Number of Animals) (Uncorrected for Effort) Across the Aerial Survey Area

Month	Harbour Porpoise	Minke Whale	White-beaked Dolphin	Bottlenose dolphin	Grey Seal	Harbour Seal	Cetacean Species	Seal/Small Cetacean Species	Seal Species	Total
8 Mar 2019	38				1			1	10	**50**
14 May 2019	181	6			16			6	65	**274**
21 Jun 2019	57	1	6		4			2	17	**87**
23 Jul 2019	54	13	3		9		1		13	**93**
6 Aug 2019	28	2			7				6	**43**
15 Sep 2019	20		4		6		3	3	7	**43**
17 Oct 2019	25			1	12		1	5	13	**57**
19 Nov 2019	14				1				9	**24**
7 Dec 2019	3				1			2	6	**13**
5 Feb 2020*	9				2		6		2	**20**
19 Feb 2020	12				4			1		**17**
21 Mar 2020	11						1		3	**15**
5 May 2020**	475	3			3			2	16	**499**
16 May 2020	24	1			3			2	3	**33**
9 Jun 2020	58		1		7		1	2	32	**101**
12 Jul 2020	77	13	7		7			1	20	**125**
9 Aug 2020	39	5			7				25	**76**
6 Sep 2020	80	3	24		11			4	68	**190**
16 Oct 2020	15				11		1	2	17	**46**
5 Nov 2020	17	1			4			1	10	**33**
1 Dec 2020	46				9			6	31	**92**
19 Jan 2021	38				8	1		1	33	**81**
16 Feb 2021	39				2	1		2	11	**55**
12 Apr 2021	149			6	12			4	9	**180**
24 Apr 2021	525	9			33	1		5	38	**611**
TOTALS	**2034**	**57**	**45**	**7**	**180**	**3**	**14**	**54**	**464**	**2858**

**For the purposes of analyses the February 2020 dataset will serve as the dataset for January 2020*

***For the purposes of analyses the 5 May 2020 dataset will serve as the dataset for April 2020*

5.2.2. DENSITY ESTIMATES

77. Relative monthly densities of marine mammal species were estimated from the aerial survey data. The data were analysed using a non-parametric bootstrap approach with replacement to provide variance estimates for mean monthly densities (Buckland *et al*., 2001).

78. Density estimates with bootstrapping were undertaken for grey seal with the inclusion of data for 'seal species' on the assumption that most seals within the site were likely to be grey seal. This is supported by

the at-sea maps and telemetry data which showed that grey seals are more likely to use the offshore waters of the Proposed Development array area whilst harbour seal densities are very low in the offshore section of the Proposed Development array area (see section 6.2 for more details). Note that telemetry data suggest that there is some movement of harbour seals within the very north-west of the Proposed Development array area (closest boundary to the Firth of Tay and Eden Estuary) and therefore the presence of this species has not been discounted, however there are insufficient data to allow density estimates in this report.

79. Spatial density estimates were also produced for harbour porpoise and grey seal (including 'seal species') on a seasonal basis: winter (December, January February); spring (March, April, May); summer (June, July, August); and autumn: (September, October, November). It was not possible to produce model-based density estimates for other marine mammal species within the Proposed Development marine mammal study area due to low numbers of sightings. Model-based analyses was undertaken in the programme MRSea (Scott-Hayward *et al.,* 2013) with environmental covariates used to predict species distributions. To reduce the potential for edge effects near the boundaries of the survey area, the maps were clipped to a smaller area: Proposed Development array area plus ~12 km buffer.

80. Mean seasonal abundance estimates were also derived from the spatial density maps by summing densities within each km^2 grid cell and scaling the data up from the clipped area to cover the Proposed Development plus 16 km survey area. Seasonal abundance estimates are presented in the species accounts for harbour porpoise (section 6.1.1) and grey seal (including 'seal species') (section 6.2.2).

81. Densities and abundance, presented as relative estimates, were subsequently corrected for availability bias to provide an approximation of absolute numbers. Correction factors were derived from studies on dive behaviour of marine mammals and their availability at the surface (further detail of correction factors is provided in section 3.5 of Annex A).

82. Annex A provides a full description of the analyses and a summary of the mean monthly density estimates are provided in Table 5.4.

Table 5.4: Estimated Densities Based on the Aerial Survey Data (March 2019 to April 2021)

Species	Mean Relative Density (Animals per km^2)	Availability Bias Correction Factor Applied	Mean Corrected Density (Animals per km^2)	Corrected 95% CI (lower)	Corrected 95% CI (upper)
Harbour porpoise (bootstrapping)	0.127	0.425	0.298	0.159	0.449
Harbour porpoise (MRSea)	0.127	0.425	0.299	0.155	0.652
Grey seal (bootstrapping)	0.041	0.156	0.263	0.175	0.353
Grey seal (MRSea)	0.043	0.156	0.276	0.154	0.532
Minke whale	0.007	0.443	0.016	0.009	0.023
White-beaked dolphin	0.009	0.180	0.050	0.017	0.094

6. SPECIES ACCOUNTS

83. The following section provides more detailed baseline information for each of the key species identified within the Proposed Development marine mammal study area. These are:

- harbour porpoise;
- bottlenose dolphin;
- white-beaked dolphin;
- minke whale;
- harbour seal; and
- grey seal.

6.1. CETACEANS

6.1.1. HARBOUR PORPOISE

Ecology

84. Porpoises comprise a group of relatively small-bodied Odontoceti (toothed) cetaceans within the family Phocoenidae. The harbour porpoise is one of the smallest cetacean species, reaching a maximum length of 1.9 m. On average females grow to a length of 1.6 m whilst males reach 1.45 m in length (Lockyer, 1995). Although the recorded longevity is 24 years, most individuals do not live past 12 years of age (Lockyer, 2003).

85. Often living in cool, high latitude waters, harbour porpoise have a higher metabolic rate than dolphins and therefore need to feed more frequently and consume more prey per unit body weight, in order to maintain their body temperature and other energy needs (Rojano-Doñate *et al.,* 2018). For this reason, porpoise may be highly susceptible to changes in the abundance of prey species or disturbance from foraging areas. Harbour porpoise feed on a wide range of fish species, but mainly small shoaling species from demersal or pelagic habitats (Santos and Pierce, 2003; Aarfjord, 1995). There are regional and seasonal differences in diet; interannual variation depending on the availability of prey species; and ontogenetic variation (adult and juveniles), with juveniles targeting smaller species such as gobies (*Gobiidae*) or smaller individuals of the same prey species targeted by adults (Santos and Pierce, 2003). A harbour porpoise's field metabolic rate remains stable over seasonally changing water temperatures. Heat loss is deemed to be managed via cyclical fluctuations in energy intake to build up a blubber layer that offsets the extra cost of thermoregulation during winter (Rojano-Doñate *et al.,* 2018). Ransijn *et al.* (2019) produced energy maps for various harbour porpoise prey species and found that the energy available in the North Sea is highest in the summer and the main energic contributions were from sandeels *Ammodytidae* and whiting *Merlangius merlangus*. During the winter season European sprat *Sprattus sprattus* and Atlantic herring *Clupea harengus* also contributed to the overall energy density (Ransijn *et al.,* 2019). This study corroborated findings of previous studies of harbour porpoise off the east coast of Scotland which reported that sandeel is the dominant prey item during summer (Santos *et al.,* 2004).

86. Harbour porpoise regularly forage around tidal races, overfalls, and upwelling zones during the ebb phase of the tide (Pierpoint, 2008). Embling *et al.* (2010) analysed results of the dedicated surveys conducted in the southern Inner Hebrides and found that maximum tidal current is the best environmental explanation of persistent harbour porpoise abundance, although in contrast to other studies, they found that densities were higher in areas of low current. Although harbour porpoise generally hunt alone or in small groups, this species is often seen in larger aggregations of 50 or more individuals, either associated with food concentrations or seasonal migrations. Within these loose aggregations, segregation may occur, with females travelling with their calves and yearlings, and immature animals of each sex being segregated into groups.

87. The age at sexual maturation for the harbour porpoise is approximately three to four years and reproduction is strongly seasonal with mating occurring between June and August (Lockyer, 1995). Gestation is

ten to eleven months and there is a peak in birth rate around the British Isles during the months of June to July (Boyd *et al*., 1999).

88. The main threats to the harbour porpoise in the northern North Sea in by-catch in fishing gears. Harbour porpoise are particularly vulnerable to getting caught in bottom-set gill nets as a result of their feeding behaviour. Other threats include prey depletion, pollution that may affect the health of individuals, as well as acoustic and physical disturbance (Evans and Prior, 2012).

Distribution and occurrence

89. Harbour porpoise is widely distributed throughout the North Sea and through the regional marine mammal study area. Heinänen and Skov (2015) found that in the North Sea MU the water depths and hydrodynamic variables are the most important factors for the probability of presence of harbour porpoise. During summer, animals seem to avoid well-mixed areas showing preference to more stable areas. Studies indicated lower presence with decreasing practical salinity unit values, reflecting an avoidance of estuarine water masses.

90. Based on spatio-temporal modelling using species and environmental data, Heinänen and Skov (2015) concluded that during summer harbour porpoises avoid muddy sediments and hard bottom areas. A study using long term passive acoustic data revealed, however, that, within the Moray Firth, harbour porpoise occurred in both sandy and muddy habitats (Williamson *et al.,* 2016). The study also found that the proportion of hours with acoustic detection in muddy habitats increased during the night by 18% (Williamson *et al.,* 2016). Porpoise detections also differed in response to depth in the different sediment types during the night and day. In muddy, deeper areas (50 m to 60 m) detections at night were nearly double those during the day. Therefore, it can be assumed that harbour porpoises use different types of habitats during the day and at night and therefore their distribution may shift accordingly.

91. The Heinänen and Skov (2015) analysis concluded that in the summer months, harbour porpoise presence in the North Sea MU was best predicted by season, water depth and salinity of surface waters. In the winter months the presence of harbour porpoise was best predicted by the season, water depth and the seabed surface sediments. For the winter months the modelling showed a peak in presence was observed at water depths of 30 to 40 m and that animals seemed to avoid waters with high current speeds as well as avoiding areas with muddy bottom substrates.

92. Harbour porpoise was the most commonly identified cetacean during historic aerial surveys in the FTOWDG region (Grellier and Lacey, 2011) and Seagreen Firth of Forth Round 3 boat-based surveys (Sparling, 2012). Harbour porpoises were distributed across the survey area (Figure 6.1) but there were a greater number of sightings offshore, most often seen singly although group size ranged from one to six individuals. The harbour porpoise was also recorded on all boat-based surveys and in all parts of the site (particularly near the morphological bank features such as Scalp Bank to the north from the Proposed Development array area running down to the centre of the Proposed Development array area; Figure 6.2). These areas may represent good foraging grounds due to the sandy banks providing good habitat for prey species such as sand eel and whiting, both of which have been recorded as important constituents of the diet of harbour porpoises on the east coast of Scotland, with the relative proportion of each of these in the diet changing seasonally (Santos *et al*., 2004).

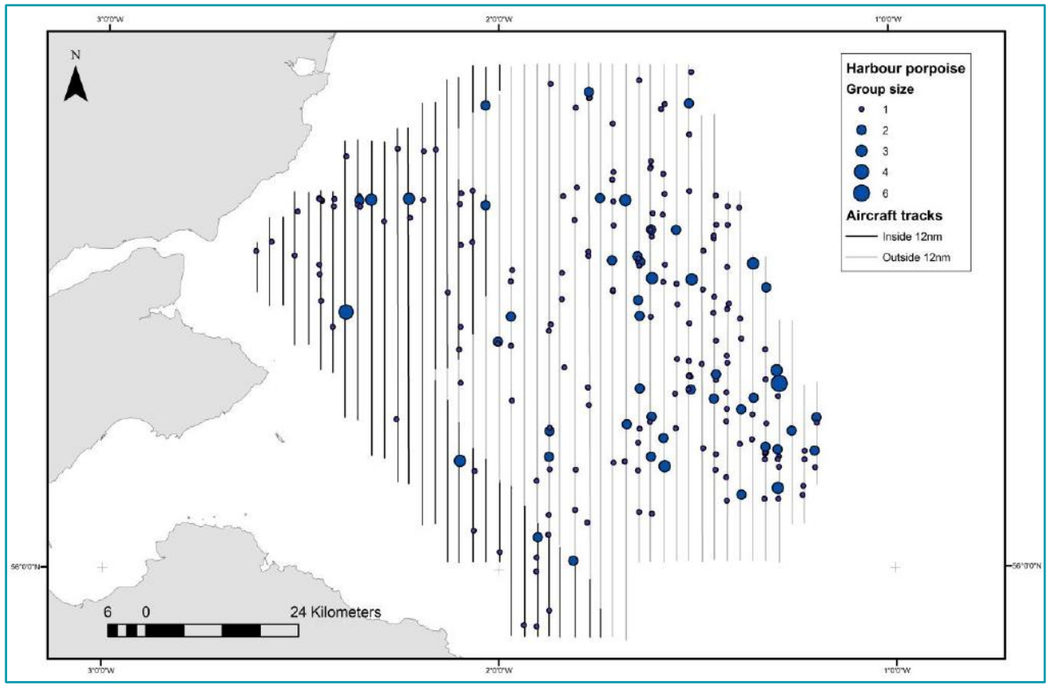

Figure 6.1: Harbour Porpoise Distribution and Group Size During Historical Aerial Surveys Across All Seasons from May 2009 to March 2010. Source: Grellier and Lacey (2011)

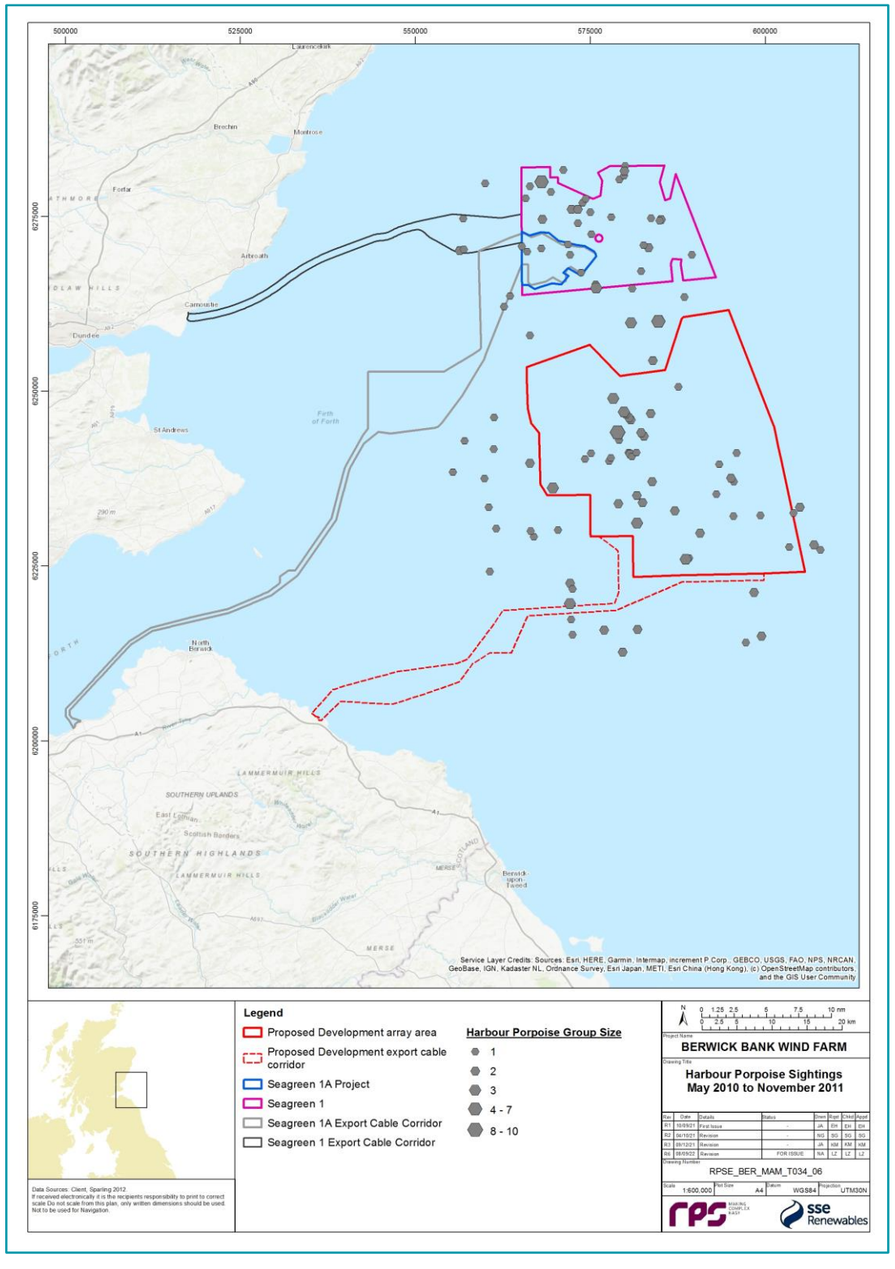

Figure 6.2: Positions of Harbour Porpoise Sightings Across All Seasons During the Firth of Forth Round 3 Boat-based Surveys from May 2010 to November 2011 (Sparling, 2012)

93. The Proposed Development aerial digital survey data showed that harbour porpoise was distributed throughout the Proposed Development marine mammal study area (see species distribution maps in Annex A). Sightings occurred throughout the survey area, however the presence of harbour porpoise in May 2019 and June 2019 is more evident in the south-east area of the Proposed Development array area (see Figure 3.4 to Figure 3.10 in Annex A). The spatial density maps produced using MRSea showed that during spring, the eastern half of the survey area appeared to be favoured by harbour porpoise (see Figure 3.19 in Annex A). The highest encounter rate of harbour porpoise during these aerial surveys was 0.212 individuals per km in April 2021 (Figure 6.3). Mean monthly encounter rate was calculated as 0.037 (95% CI = 0.011 to 0.062). Harbour porpoise also had the second greatest overall encounter rate (0.013 sightings per km) from all marine species recorded during historic aerial surveys in the FTOWDG region (Grellier and Lacey, 2011).

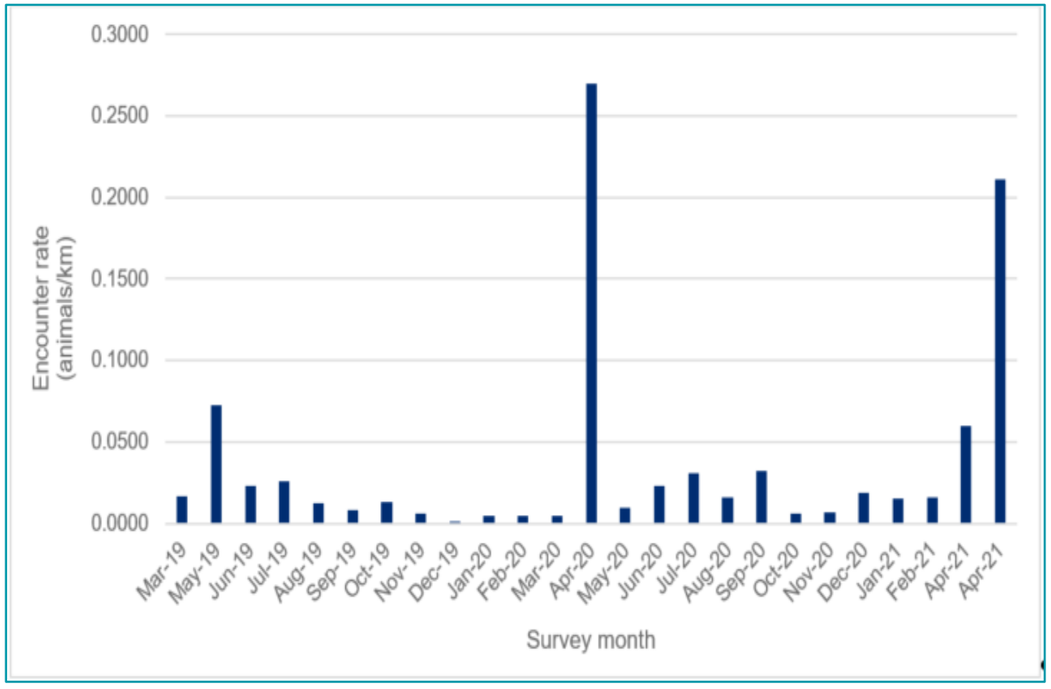

Figure 6.3: Monthly Encounter Rate of Harbour Porpoise within the Proposed Development marine mammal study area (Aerial Survey Data March 2019 to April 2021)

Density/abundance

94. Density and abundance estimates were available across a broader area within the regional marine mammal study area. The abundance estimated for cetaceans, outlined in IAMMWG (2021) are based on the results of the SCANS III (Hammond *et al.,* 2017) and the ObSERVE Programme (Rogan *et al.,* 2018). IAMMWG (2021) estimated abundance for the North Sea MU (Figure 6.4) as 346,601 (CV = 0.09, 95% CI = 289,498 to 419,967) harbour porpoise. These results are much higher than previous estimates reported

by IAMMWG (2015) with 227,298 (CI = 0.13, 95% CI = 176,360 to 292,948) animals. However, IAMMWG (2021) results are aligned with those presented by Hague *et al. (*2020), as this study reported harbour porpoise estimated abundance in the North Sea MU as 345,373 animals (CV =0.18, 95% CI = 246,526 to 495,752).

95. SCANS II estimated the average density in Block V as 0.293 animals per km^2 (CV = 0.36), with a mean group size of 2.37 (CV = 0.21) (Figure 6.5; Hammond *et al*., 2013). The total abundance in Block V was estimated as 47,048 animals (CV = 0.36) corrected for group size. The more recent SCANS III data estimated the density in block R as 0.599 animals per km^2 with abundance estimates of 38,646 animals (CV = 0.29, 95% CI = 20,584 to 66,524; Figure 6.6; Hammond *et al.,* 2021). Due to the change in survey blocks used in the SCANS II and SCANS III surveys, direct comparison between the surveys for abundance and density estimation is not possible.

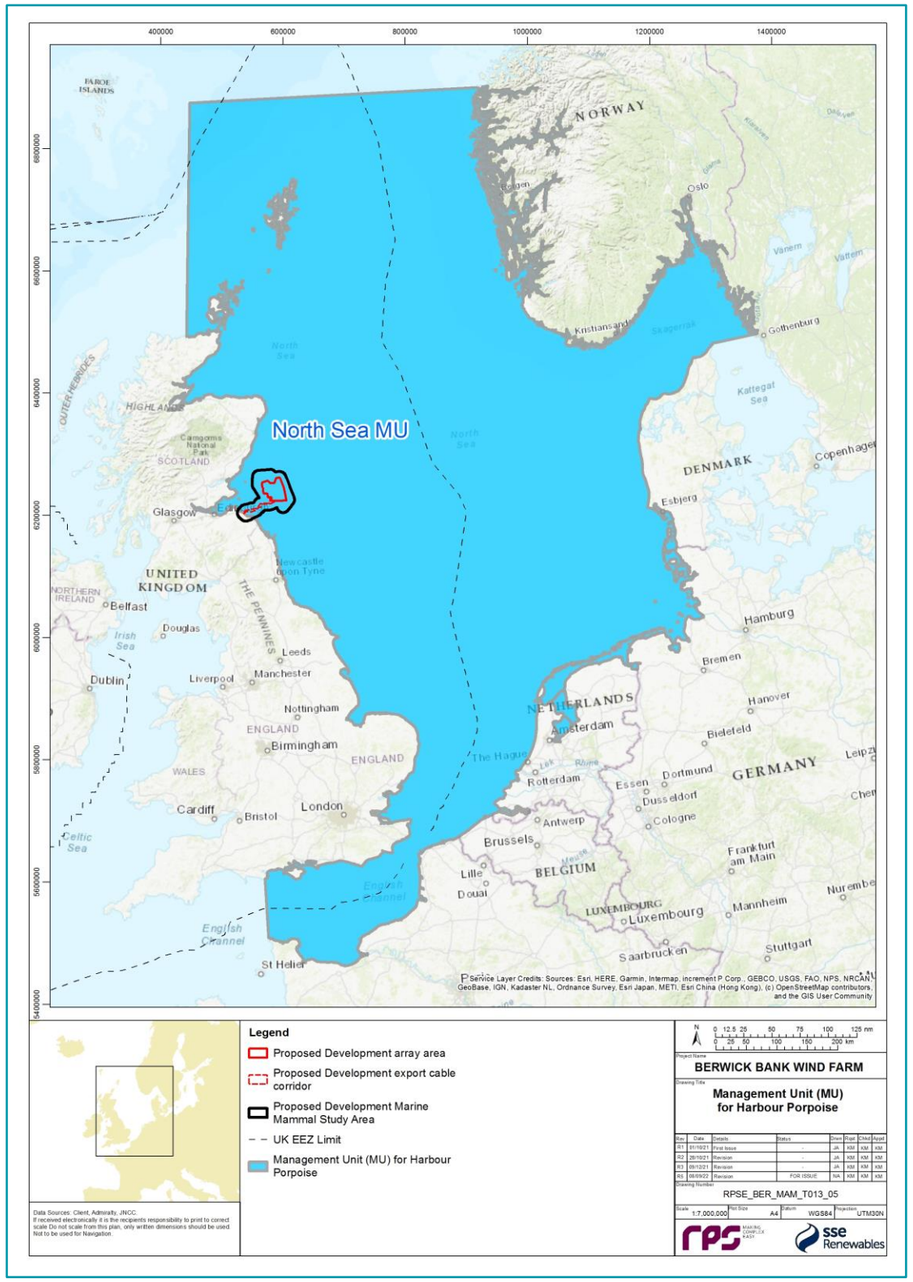

Figure 6.4: Management Unit (MU) for Harbour Porpoise

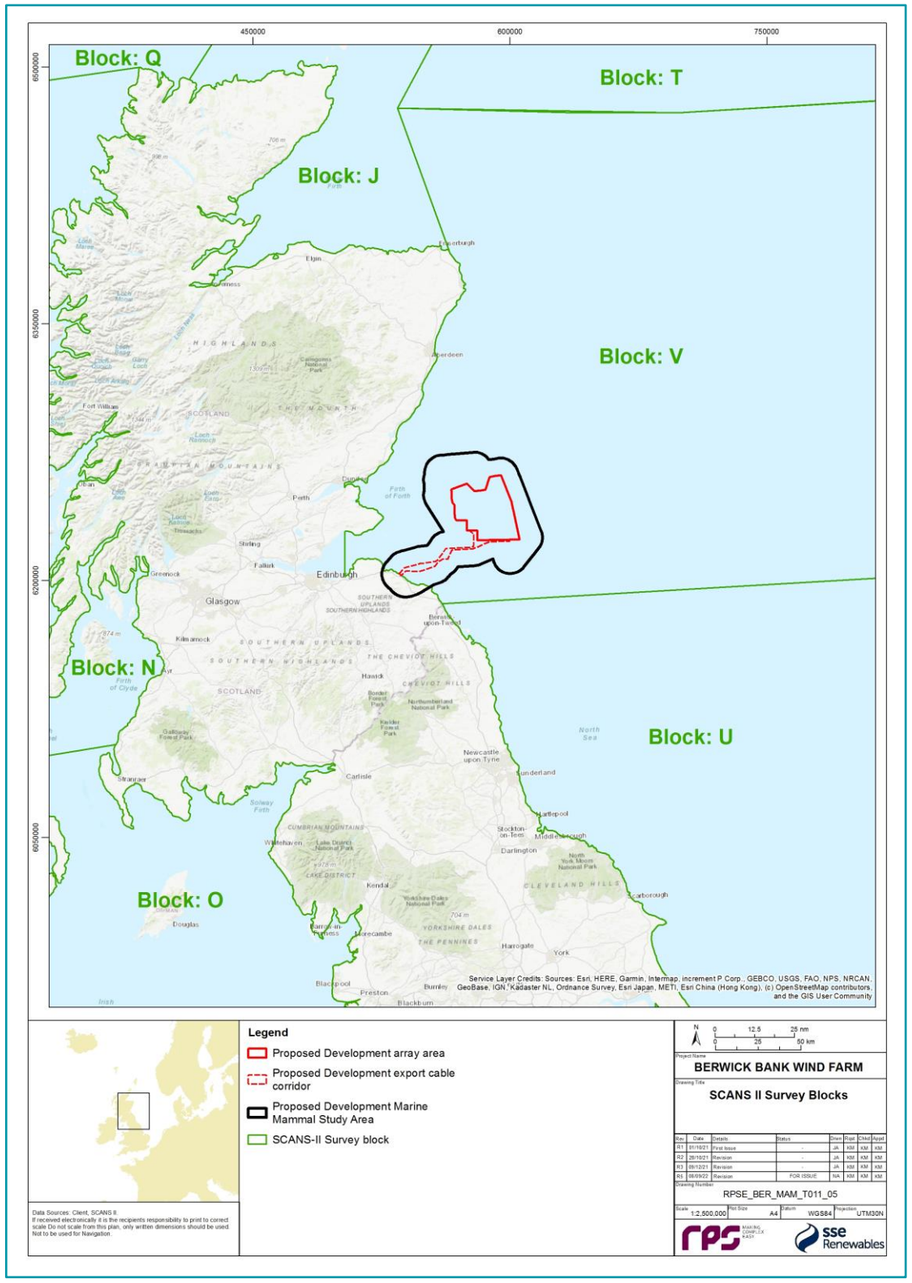

Figure 6.5: SCANS II Survey Blocks

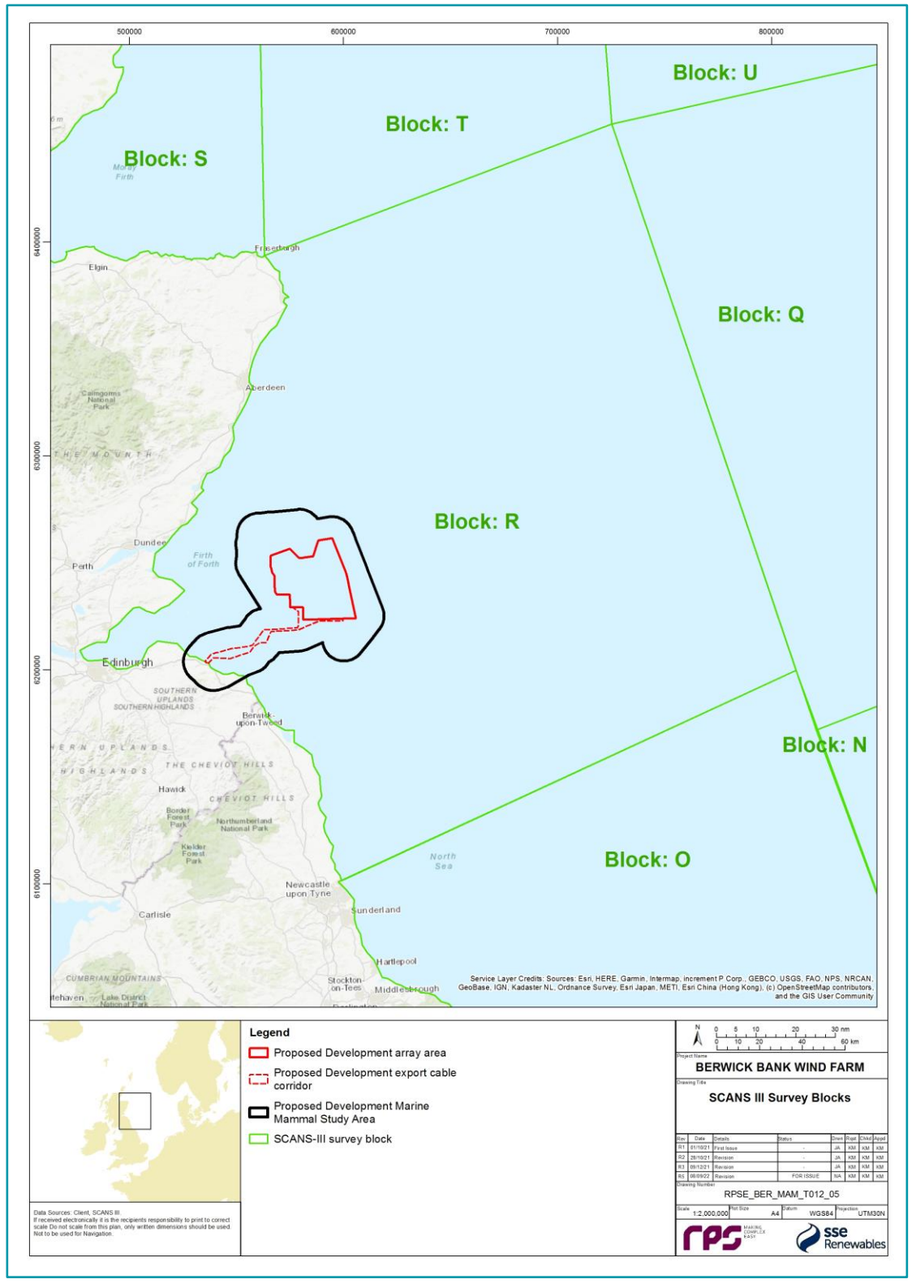

Figure 6.6: SCANS III Survey Blocks

96. The JCP Phase III analyses provided estimated abundances for harbour porpoise in 2010 by season for the Firth of Forth area of commercial interest region which covered 14,241 km^2 (Figure 6.7; Paxton *et al.,* 2016). Highest abundance of harbour porpoise was estimated for the winter months, with 7,000 (97.5% CI = 5,200 to 11,800) animals. Similar abundances were estimated in spring and summer with 3,500 (97.5% CI = 1,900 to 6,600) and 4,400 (97.5% CI = 2,900 to 6,800) harbour porpoise respectively. The lowest abundance was estimated in autumn with 2,500 (97.5% CI = 1,600 to 3,600) animals (Paxton *et al.,* 2016). These equated to density estimates of 0.492 animals per km^2 in the winter, 0.246 animals per km^2 in the spring, 0.309 animals per km^2 in the summer and 0.176 animals per km^2 in the autumn (Paxton *et al.,* 2016). These values are lower compared to the estimated density presented in SCANS III report with 0.599 animals per km^2 (Hammond *et al.,* 2021).

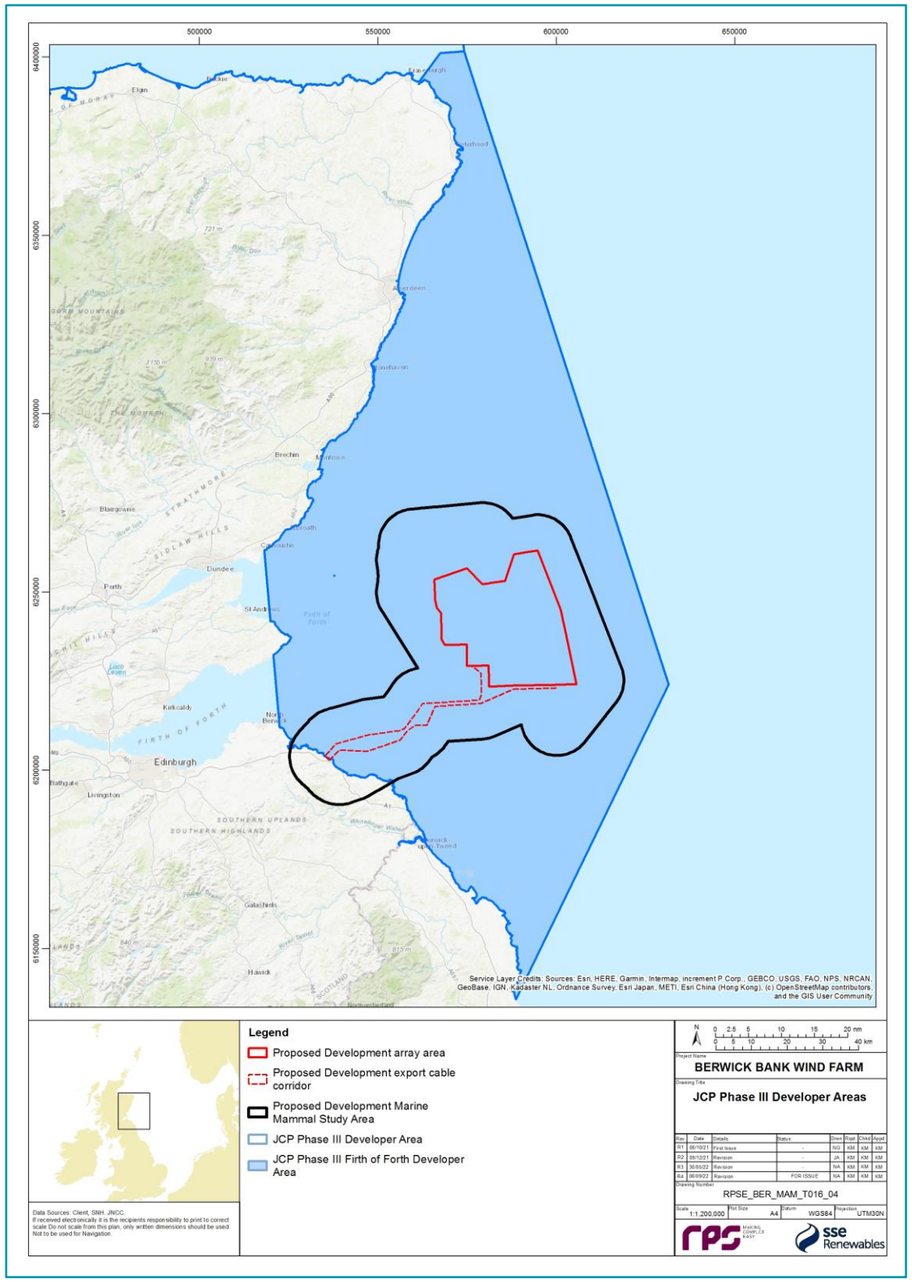

Figure 6.7: JCP Phase III Areas of Interest

97. Paxton *et al.* (2016) reported the predicted abundance in the Firth of Forth as a percentage of the overall predicted number for the North Sea MU (based on estimates for summers 2007 to 2010) as 1.4% (97.5% CI = 0.6 to 2.3). Estimated trend (average annual population change) for harbour porpoise in the Firth of Forth between reporting period 1992 to 2000 and 2007 to 2010 was indicating a 14% (95% CI = 1 to 31) increase per year with a statistically significant trend at the 5% level.

98. The Heinänen and Skov (2015) analysis concluded that areas of persistent high densities are estimated in the outer Moray Firth. The density estimates within the outer Firth of Forth and Firth of Tay region were predicted to be relatively low compared to other parts of the North Sea. Paxton *et al.* (2016) corroborated this finding by reporting that the Firth of Forth and the east coast of Scotland was not identified as associated with the highest density for this species, compared to other regions such as west coast of Ireland or the Hebrides and that higher abundance was correlated with Moray Firth.

99. Harbour porpoise was the most common cetacean species encountered during historic aerial surveys with the mean density of 0.080 (CV=0.11) individuals per km^2 (Grellier and Lacey, 2011). Summer density estimates were calculated to be 0.099 (CV=0.12) individuals per km^2, and winter 0.048 (CV=0.24) individuals per km^2. These density estimates were minimum estimates based on inherent negative bias due to the survey methodology (Mackenzie *et al.,* 2012). Therefore, spatially explicit density surfaces were generated using all FTOWDG aerial and Round 3 boat-based sightings (Mackenzie *et al.,* 2012, section 5.2). When all data across all years were pooled, depth was a significant predictor of occurrence, with fewer animals in shallow water. The data showed a great deal of variation in the spatial distribution of harbour porpoise across the survey years, with the main predictor of density being survey methodology. The likely explanation for variation in densities across the survey area may relate to changes in prey distribution. After correcting for availability, Mackenzie *et al. (*2012) estimated absolute abundance for the survey area (aerial and boat-based) across the survey period as 582 (95% CI = 581 to 1235). The correction factor (i.e. probability of an animal being available to be seen at the sea surface) for harbour porpoise was 0.434 (McKenzie *et al.,* 2012). Harbour porpoise was also the most frequently recorded species of cetacean during Neart na Gaoithe boat-based surveys undertaken each month between November 2009 and October 2012 (Neart na Gaoithe, 2018).

100. Seasonal density estimates calculated from the Proposed Development aerial digital survey data highlighted that in spring months there were more harbour porpoise within the Proposed Development marine mammal study area. Mean monthly density was estimated as 0.127 (95% CI = 0.066 to 0.277) animals per km^2. Correcting this for availability bias based on tagged porpoises in the Baltic/North Sea (Teilman *et al.,* 2013) mean monthly density was estimated as 0.299 (95% CI = 0.155 to 0.652) animals per km^2 with a peak mean density during spring months of 0.826 (95% CI = 0.440, 1.616) animals per km^2 (Table 6.1:). Corrected abundance of harbour porpoise within the Proposed Development marine mammal study area ranged between 460 animals in winter and 4,108 animals in spring.

Table 6.1: Harbour Porpoise Modelled Absolute Density Estimates by Season for Proposed Development Array Area Including Lower Confidence Intervals (LCI) and Upper Confidence Intervals (UCI). Mean Seasonal Abundance is Scaled up to the Proposed Development Array Area Plus ~16 km Buffer

Season	Mean Absolute Abundance	Mean Absolute Density (Animals per km^2)	LCI	UCI
Winter	460	0.092	0.045	0.195
Spring	4108	0.826	0.440	1.616
Summer	883	0.179	0.099	0.341
Autumn	479	0.096	0.035	0.452
All months	**-**	**0.299**	**0.155**	**0.652**

Seasonality

101. Comparison of harbour porpoise encounter rate during different seasons based on the historic aerial surveys in the FTOWDG region showed that harbour porpoises were recorded nearly three times as often in summer (2.01 sightings per 100 km) compared to winter (0.70 sightings per 100 km) (Grellier and Lacey, 2011). The same pattern of higher encounter rates during summer months was also recorded during boat-based surveys (Sparling, 2012). The Seagreen boat-based surveys in summer 2017 recorded the highest counts of harbour porpoise between in May and July (Seagreen Technical Report, 2018). These findings are different to JCP Phase III results, as the study reported highest densities of harbour porpoise during winter months (Paxton *et al.,* 2016).

102. Similarly, there is a temporal trend emerging from the DAS, with highest encounter rates during spring months each year (April and May, Figure 6.3). Harbour porpoise encounter rate was lowest during winter and autumn (from November 2019 to March 2020 and from October 2020 to February 2021). MRSea modelling corroborated the above as the results showed highest densities during spring months and lowest densities during winter (see Annex A for more details).

6.1.2. BOTTLENOSE DOLPHIN

Ecology

103. Bottlenose dolphin are members of the family *Delphinidae*, which are oceanic dolphins found in temperate and tropical waters worldwide. The largest of the beaked dolphins, this species ranges in size from 1.9 to 3.8 m and can live, on average, between 20 to 30 years. On average, males reach sexual maturity at ten to 12 years and females at five to ten years. Mating occurs during the summer months, with gestation taking 12 months and calves suckling for 18 to 24 months. Females generally reproduce every three to six years (Mitcheson, 2008).

104. There is variation in the patterns of habitat use of bottlenose dolphin, even within a population, and generally the distribution of this species is influenced by factors such as tidal state, weather conditions, resource availability, life cycle stage, or season (Hastie *et al.,* 2004). Typical prey items in Scottish waters include cod *Gadus morhua*, saithe *Pollachius virens*, whiting, salmon *Salmo salar* and haddock *Melanogrammus aeglefinus* (Santos *et al.,* 2001).

105. Bottlenose dolphin is frequently seen in groups rather than individually, although group size in coastal populations may be smaller than offshore populations; however, very little is known about offshore populations (Rogan *et al*., 2018). Mean group size across the SCANS III survey areas was 5.25 individuals (Hammond *et al,* 2021). Robinson *et al. (*2017) reported that in north-east Scotland observed group sizes varied between two and 70 animals, with a mean of 14.2. It is important to highlight that the surveys were conducted along the southern coastline of the outer Moray Firth, in close vicinity of the SAC (between the coastal ports of Lossiemouth and Fraserburgh).

Distribution and occurrence

106. The Moray Firth SAC boundary encompassed the core area of occurrence of the resident population of bottlenose dolphins in the North Sea based on the data collected in 1980s and early 1990s. However, studies have shown that the population of bottlenose dolphins off the east coast of Scotland is highly mobile with individuals ranging from Moray Firth to Firth of Forth (Quick *et al.,* 2014; Cheney *et al.,* 2018; Arso Civil *et al.,* 2019; Arso Civil *et al.,* 2021). Therefore, this range was established as the main distributional range of the population (Quick *et al.,* 2014; Cheney *et al.,* 2013).

107. Acoustic occupancy rates and habitat modelling in the ECOMMAS study highlighted that the waters between Stonehaven and Aberdeen are a potential area of high occupancy (Palmer *et al.,* 2019). Instruments deployed in the Stonehaven group showed the second highest acoustic occupancy rates behind the Cromarty group (area close to Moray Firth). Quick *et al. (*2014) established that a high proportion of bottlenose dolphins from the east coast of Scotland population use both the Tayside and Fife area and the Moray Firth SAC, over a range of temporal scales. The same study reported that most encounters occurred at the entrance of the Tay (35 to 46% of the east coast of Scotland population) and that bottlenose dolphins were only seen on the north side of the Forth, mostly between Anstruther and Fife Ness. These findings were corroborated by Arso Civil *et al. (*2019) who reported that that the east coast population expanded its distribution range since more than a half of the estimated population was consistently using the St Andrews Bay and the Tay estuary. The ECOMMAS study reported that between 2013 and 2015 there was relatively low number of detections at the St. Andrews survey location nearest the bay and it has been suggested that this area may represent habitat associated with rest or socializing rather than foraging, therefore there are fewer clicks to detect (Palmer *et al.,* 2019). The most recent data collected during boat-based trips between Moray Firth and Fife Ness (during summers 2017 to 2019) shows that the Tay estuary area and adjacent waters continues to be used by more than a half of the total estimated population every summer (in 2019 approx. 53.5%; Arso Civil *et al.,* 2021). This study also reported that the number of animals estimated to be using this area has increased by around 4.3% per year between 2009 and 2019, although it decreased between 2017 and 2019. The author suggested that it is likely that changes in the distribution range are continuing with a further southern range expansion (Arso-Civil *et al.,* 2021). In 2007 there was one confirmed sighting of a group near Whitley Bay and the Tyne River mouth (Cheney *et al.,* 2013) and there are ongoing citizen science projects, which results in bottlenose dolphin sightings being reported as far as the Farne Islands (Chronic Live, 2020). However, C-PODs deployed at St. Abbs had very low (<5%) broadband occupancy rates for all survey years (2013 to 2015). There is currently no reported survey effort to the south of the Firth of Forth that would indicate an increase in numbers of bottlenose dolphins present in the area.

108. The ECOMMAS C-POD study (Palmer *et al.,* 2016) found that broadband acoustic occupancy rates throughout the survey were generally higher for C-PODs closer to the shoreline which corroborates findings of Thompson *et al.* (2015) suggesting the bottlenose dolphins are more likely to be observed in coastal waters, within 5 km of shore and therefore are unlikely to be present in the offshore areas that may be exposed to significant construction noise from offshore wind farms. These results were corroborated by Quick *et al.* (2014) as the study reported that dolphins were mostly encountered in waters less than 30 m deep, generally in waters between 2 m and 20 m and within 2 km from the coast (Figure 6.10). Paxton *et al.* (2016) also described bottlenose dolphin distribution as coastal and no bottlenose dolphins were recorded offshore for three years (2009 to 2012) of boat-based surveys within the Neart na Gaoithe Offshore Wind Farm area (Neart na Gaoithe, 2018).

109. Bottlenose dolphins were also positively identified in historic inshore (inside 12 nm) and offshore (outside 12 nm) aerial surveys between May 2009 and March 2010 (Grellier and Lacey, 2011). During summer there was just one encounter of one individual outside 12 nm and during winter two sightings of three individuals were recorded inside 12 nm. The average encounter rate of bottlenose dolphin during aerial surveys was 0.0002 individuals per km (Grellier and Lacey, 2011). Some unidentified cetacean and dolphin species were also recorded, in each case with an encounter rate of 0.0012 individuals per km, although no distinction was made between species for these sightings. No bottlenose dolphins were encountered during Seagreen Firth of Forth Round 3 boat-based surveys between 2010 and 2011 (Sparling, 2012).

110. Bottlenose dolphins were recorded in low numbers during the DAS, with one and six individuals encountered in October 2019 and April 2021, respectively. The encounter rate varied between 0.0005 individuals per km in October 2019 and 0.0024 individuals per km in April 2021 (see Annex A for more details).

Density/abundance

111. Cheney *et al.* (2013) reported that the population estimate of bottlenose dolphin abundance for the Coastal East Scotland MU (Figure 6.8) population is 195 individuals (95% CI = 162 to 253) based on photo ID counts between 2006 and 2007. More recently, a study Cheney *et al.* (2018) estimated that the bottlenose dolphin population on the east coast of Scotland is increasing and varied from 129 (95% CI = 104 to 155) in 2001 to 189 (95% CI = 155 to 216) in 2015 (Figure 6.9). Based on this later study, the IAMMWG recommended that the population in the Coastal East Scotland MU for bottlenose dolphin is taken as 189 individuals (IAMMWG, 2021). However, advice from NatureScot and MSS provided during the Road Map Meetings (see Table 3.1) was to adopt the 5-year weighted average population estimate from data gathered between 2015 and 2019 (Arso Civil *et al.,* 2021). Thus, the most up-to-date bottlenose dolphin population estimate for Coastal East Scotland MU was taken as 224 individuals (Arso Civil *et al.,* 2021). Despite inter annual variability, the number of dolphins using the Moray Firth SAC between 2001 and 2016 appeared to be stable (Cheney *et al., 2018*). Interestingly, the proportion of the population that uses the Moray Firth SAC has declined due to an overall increase in population size and expansion of range; whilst the Moray Firth is clearly an important area for this population, they are not restricted to either the Moray Firth SAC or the wider Moray Firth (Cheney *et al.,* 2018).

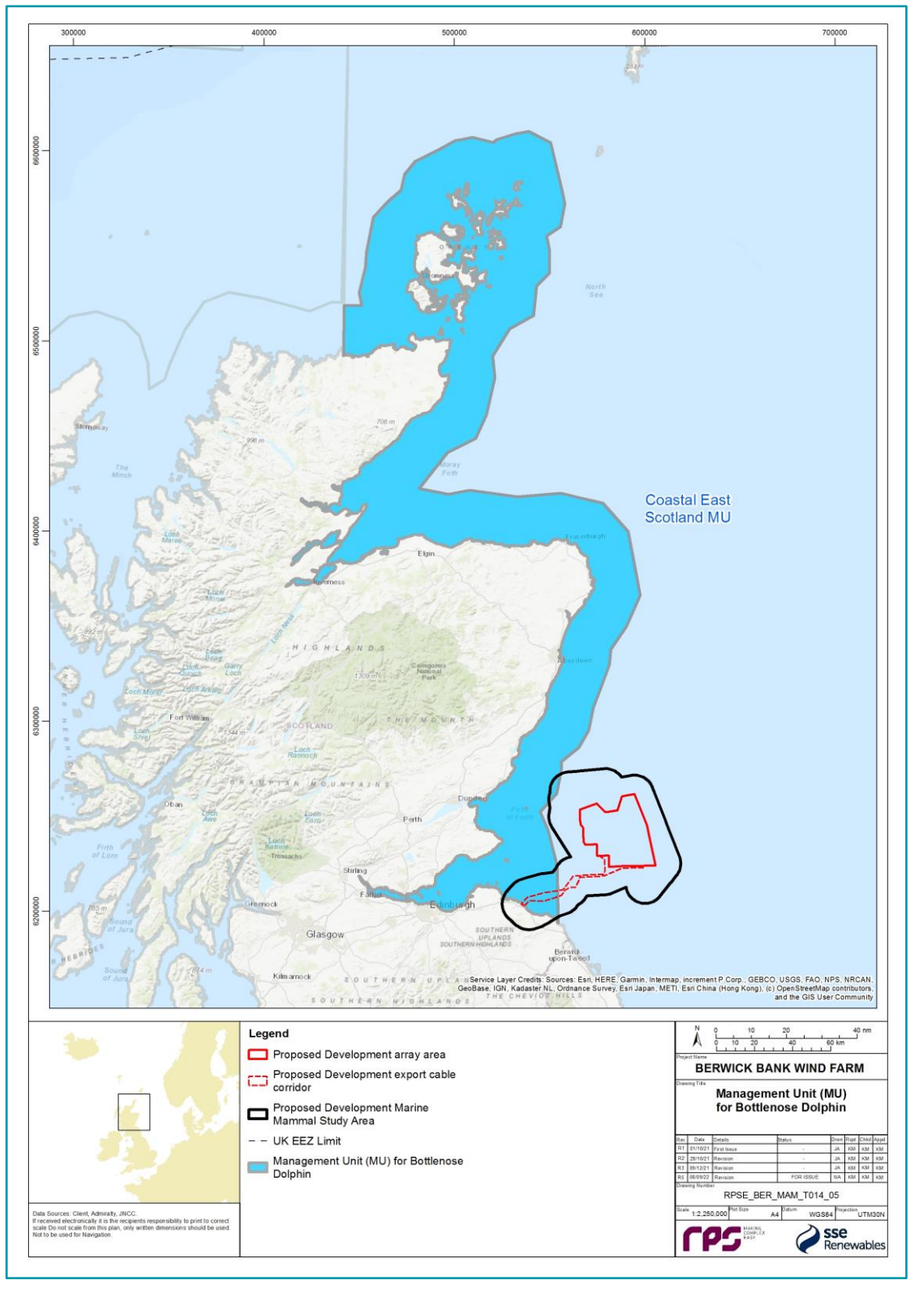

Figure 6.8: Management Unit for Bottlenose Dolphin

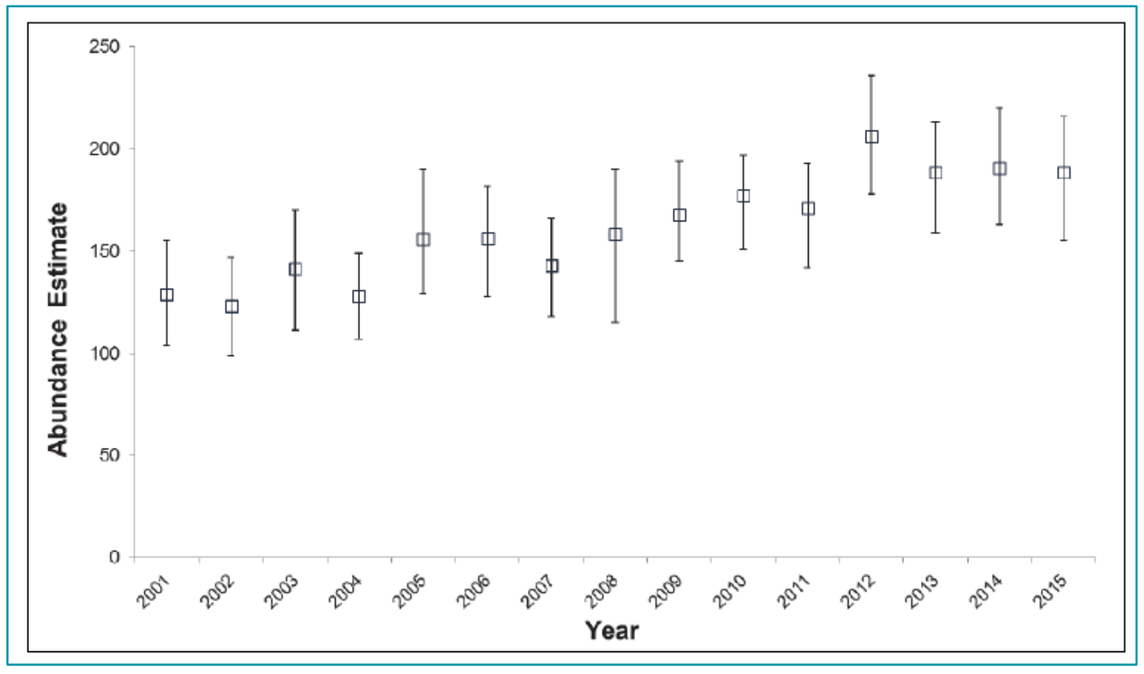

Figure 6.9: Annual Estimates of the East Coast of Scotland Bottlenose Dolphin Population from 1990 to 2015 with 9% Highest Posterior Density Intervals (HPDI). Source: Cheney *et al*., 2018

112. Based on historical photo ID data collected from 1997 to 2010 and 2012 to 2013 in the Tayside and Fife area (including Firth of Forth), Quick *et al.* (2014) reported that the majority of dolphin encounters were recorded within the Tay estuary (Figure 6.10). Between 71 and 91 bottlenose dolphins (35 to 46% of the total Scottish east coast population) were estimated to be using the Tay area during 2009 – 2013 (Quick *et al.,* 2014). Arso Civil *et al.* (2019) analysed and compared photoidentification data collected during consistent dedicated surveys from 2009 and 2015 in similar study areas to Quick *et al.* (2014), St Andrews Bay and the Tay estuary as well as the Moray Firth SAC. Over the study period, 35.2% of the marked animals were seen only in St Andrews Bay and the Tay estuary, 35.9% were seen only in the Moray Firth SAC, and 28.9% were seen in both areas. The study reported that the number of dolphins using the Tay estuary and adjacent waters increased and ranged from a minimum of 85 (95% CI = 77 to 93) animals in 2011 to a maximum of 121 (95% CI = 84 to 173) in 2014 which represented 52.5% of the estimated total east coast population (i.e. using the population's main range). The most recent study in the Tay estuary and adjacent waters integrated data collected during boat-based surveys in summers 2017 to 2019 (May to September) and data collected under the Moray Firth Marine Mammal Monitoring Programme (Arso Civil *et al.,* 2021; Graham *et al.,* 2017). This study corroborated previous findings and reported that this area continues to be used by more than half of the total estimated east coast population every summer; 53.8% between 2009 and 2019 (Arso-Civil *et al.* 2021).

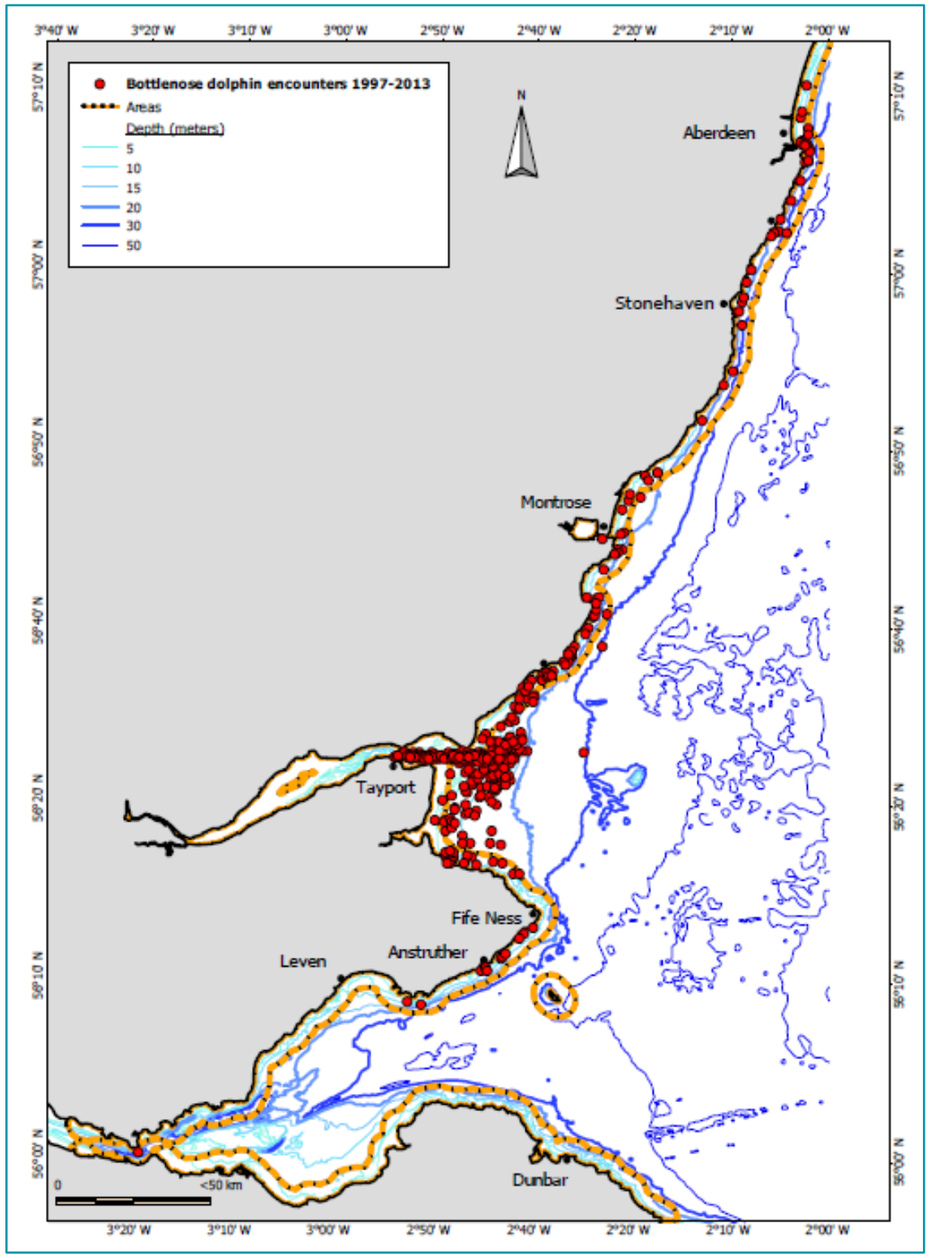

Figure 6.10: Encounter Locations from All Years (1997 to 2013) in the Tayside and Fife Data Collection Area as Defined in the Quick *et al*. (2014) Dolphin Project Database

113. The JCP Phase III analysis provided abundances for bottlenose dolphins in 2010 by season and estimated highest abundance in the Firth of Forth area of commercial interest (Figure 6.7) in spring and summer, with 460 (95% CI = 130 to 1340) and 430 (95% CI = 190 to 780) animals, respectively (Paxton *et al.,* 2016). This equates to density estimates between 0.032 individuals per km^2 in the spring and 0.030 individuals per km^2 in the summer. The lowest abundance was reported in the autumn as 190 (95% CI = 80 to 290) resulting in a density of 0.013 individuals per km^2. This density estimate for summer abundance is more than double the estimate for the east coast Scotland bottlenose dolphin population derived from Cheney *et al.* (2018). However, the JCP report authors highlight that given the patchy distribution of the JCP data resource and assumptions that had to be made to render its datasets comparable, the estimates of abundance from the JCP Phase III are less reliable than those from well-designed dedicated abundance surveys (Paxton *et al.,* 2016). Therefore, the abundance estimates obtained from the photo-ID surveys in the main population range (Cheney *et al.,* 2013; Cheney *et al.,* 2018; Arso Civil *et al.,* 2019; Arso Civil *et al.,* 2021) are likely to be better reflections of the true bottlenose dolphin population abundance along the east coast of Scotland.

114. The SCANS III estimated abundance for block R was 1,924 bottlenose dolphins (CI = 0.86, 95% CI = 0 to 5,408), with an estimated density of 0.0298 individuals per km^2 and mean group size of 5.25 individuals (Figure 6.6; Hammond *et al.,* 2021). This is a much higher estimate than the abundance estimate for the Coastal East Scotland population derived from the dedicated photo-ID surveys (Cheney *et al.,* 2018). However, studies for the Coastal East Scotland population are focused on inshore waters, and SCANS III results were obtained through large-scale surveys, including offshore waters. Studies suggest that inshore and offshore populations are often ecologically and genetically discrete (Cheney *et al.,* 2013).

115. To estimate the density of bottlenose dolphin in coastal areas, it was important to understand both the abundance and distribution of the east coast population. A five-year weighted average of the east coast bottlenose dolphin population provided an estimated population of 224 individuals (95% CI = 214 to 234) (Arso Civil *et al*., 2021). The main distributional range of this population is Moray Firth to the Firth of Forth (Cheney *et al*., 2013), however, as mentioned previously, approximately 53.8% of the east coast population (=120 individuals) use the Tay area and adjacent waters (Arso Civil *et al*., 2021). Therefore, it was assumed that the same proportion is likely to be present anywhere between Peterhead and further south as far as the Farne Islands (as recent studies reported that the east coast population is extending their range south). Previous studies reported that bottlenose dolphins are likely to be recorded within 5 km from the shore (Arso Civil *et al*., 2014; Palmer *et al*., 2019; Oudejans *et al*., 2015). Quick *et al*. (2014) provided that in the Tayside and Fife area as well as between Montrose and Aberdeen, dolphins were encountered usually in waters 2 m to 20 m deep. Therefore, the 2 m to 20 m depth contour polygon was identified as the key habitat preference of bottlenose dolphin along the east coast, between Peterhead and Farne Islands (Figure 6.11).

116. ECOMMAS data suggested that there was a patchiness in distribution along the east coast with occupancy of bottlenose dolphin (dolphin positive minutes) different across the five monitored locations (Palmer *et al*., 2019). Recent literature (Arso Civil *et al.* 2019, Arso Civil *et al.* 2021) and feedback from consultees during the Proposed Development Road Map Meetings indicated that, in particular, the Firth of Tay is an important area for the east coast bottlenose dolphin population. There were, however, no C-POD arrays located in the Firth of Tay (Figure 6.11) and therefore the occupancy of this area could not be compared with the other five areas monitored using ECOMMAS datasets. To capture the patchiness in coastal distribution of bottlenose dolphins and estimate density, a dual approach was applied. First, for all areas except the outer Firth of Tay, the east coast proportion of the population (120 animals), was assumed to be evenly distributed across the area between the 2 m to 20 m bathymetric contours, between Peterhead and the Farne Islands, giving a density of 0.197 animals per km^2 (Figure 6.11). Second, to reflect the relative importance of the outer Firth of Tay in terms of bottlenose dolphin distribution, the habitat preference map for bottlenose dolphins in the Firth of Tay and adjacent areas as modelled by Arso Civil *et al*. (2019) was

used. The map of habitat preference was analysed using the most precautionary scenario when current direction was between 300 to 010 degrees and associated bottlenose dolphin presence was recorded during the corresponding tidal condition. Four distinct segments were identified on the habitat preference maps: Fife Ness to St Andrews, Outer Firth of Tay, Arbroath and Montrose. A probability of occurrence value was assigned to each segment based on the value with widest spread across the segment and subsequently these values were used to weight each segment (as a percentage) in relation to other segments. The outer Firth of Tay had the highest weighting with a probability of occurrence of 0.8 (Figure 6.1; Table 6.2). As per the advice received from MSS on 9 December 2021, it was conservatively assumed that the 53.8% of the east coast population (120 individuals) may be present within the Firth of Tay and adjacent waters and, using the weightings, the number of bottlenose dolphins was estimated for each of the segments (Table 6.2). Subsequently, to estimate density of bottlenose dolphins specifically within the outer Firth of Tay segment the number of dolphins (53.3 individuals) was divided by the area within that segment to give 0.294 animals per km^2 (Table 6.3).

Table 6.2: Approach to Estimating Abundance in Different Sectors for the Firth of Tay and Adjacent Areas Based on Arso Civil *et al.* (2019) Habitat Preference Map

Segment	Probability of Occurrence (from Arso Civil *et al*., 2019)	Percentage (Weighting) (=Probability of Occurrence/Sum of Probabilities)	Number of Dolphins (=120 Animals*Weighted Percentage)
Fife Ness to St Andrews	0.2	11.1	13.3
Outer Firth of Tay	0.8	44.4	53.3
Arbroath	0.3	16.7	20.0
Montrose	0.5	27.8	33.3
Totals	**1.8**	**100**	**120**

117. Within the Proposed Development array area (offshore), the density of bottlenose dolphin was taken as 0.0298 from SCANS-III (Hammond *et al.,* 2021) as described in paragraph 114 (Table 6.3).

Table 6.3: Summary of Bottlenose Dolphin Densities for Different Sections Within the Regional Marine Mammal Study Area

Section	Density (Animals per km^2)
Peterhead to Farne Islands (except for Firth of Tay); 2 to 20 m depth contour	0.197
Outer Firth of Tay; 2 to 20 m depth contour	0.294
Offshore	0.0298

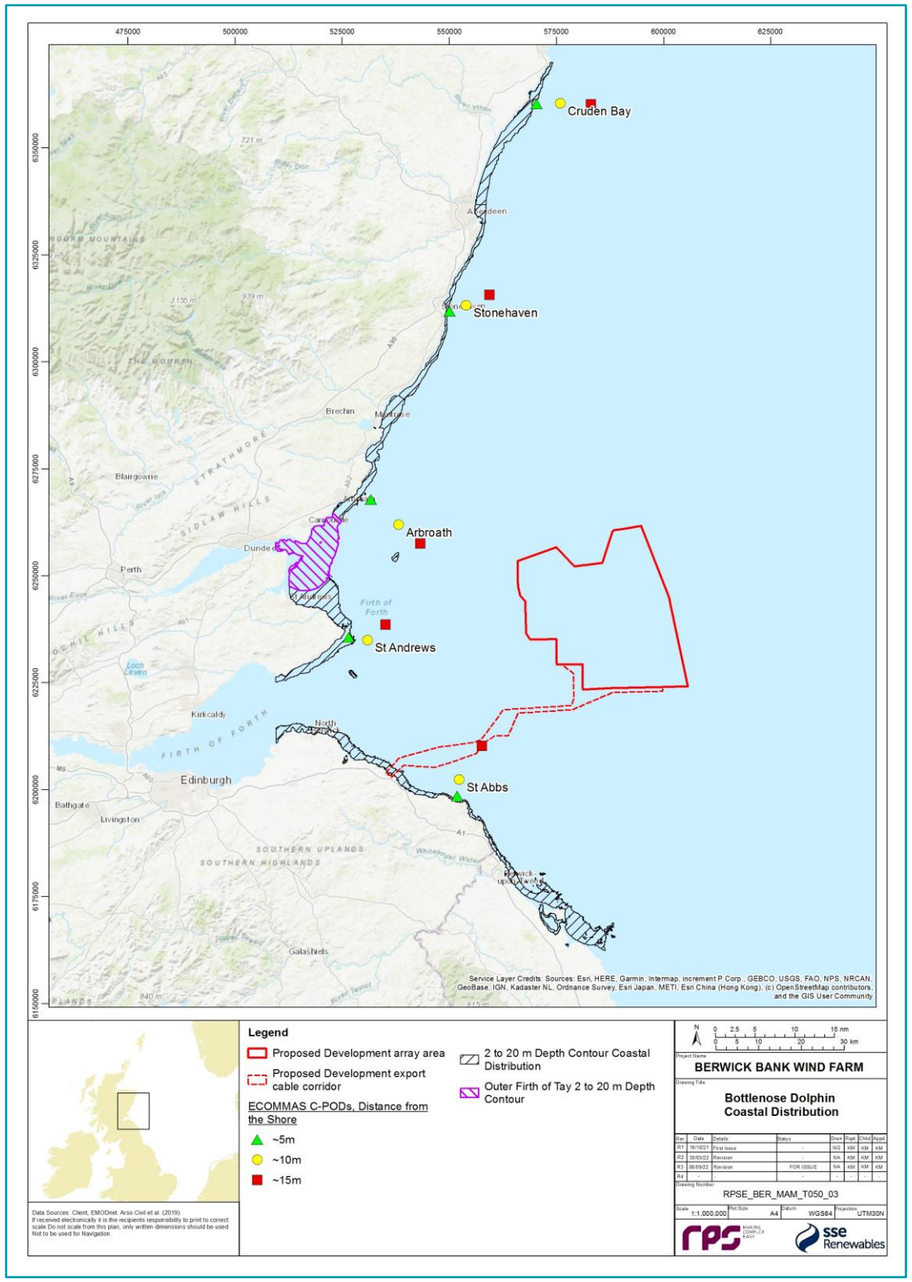

Figure 6.11: Bottlenose Dolphin Distribution within the 2 m to 20 m Depth Contour

Seasonality

118. Estimates presented by Paxton *et al.* (2016) for the Firth of Forth area shown that bottlenose dolphins are more abundant during spring and summer.

119. Breeding in bottlenose dolphins is usually seasonal and varies with location; in the Moray Firth the peak calving period is in the late summer (Culloch and Robinson, 2008). Between 2001 and 2016 a total of 169 calves were identified on the east coast of Scotland, with an average of 11 calves born each year (range three to 20) (Cheney *et al.,* 2018). The survival rate for bottlenose dolphins in the Moray Firth SAC has been estimated as 0.93 (95% CI = 0.91 to 0.94) based on data from 161 well marked animals sighted between 1990 and 2014 (Graham *et al.,* 2016).

120. DAS recorded sightings of bottlenose dolphin in October and April only. Thompson *et al.* (2011) reported that in the Moray Firth, three times as many individuals occurred within inshore waters in the summer compared to the winter months. It has been suggested that this seasonal inshore occurrence of bottlenose dolphin may be linked to periods when animals move into warmer shallow waters to calve and nurse their young during the summer months. Other driving factors may also include seasonal distribution of prey species.

6.1.3. WHITE-BEAKED DOLPHIN

Ecology

121. The white-beaked dolphin occurs over a large part of the northern European continental shelf. It is the second most numerous cetacean in the North Sea, recorded more frequently in the western sector of the central and northern North Sea across to western Scotland and is generally sighted in small groups of three to four animals (Weir *et al.,* 2001; Reid *et al.,* 2003).

122. White-beaked dolphin can grow up to 3.5 m for males and 3.05 m for females. Adults become sexually mature at a length of approximately 2.6 m and at approximately 12 to 13 years of age (Reeves *et al*., 1999b). White-beaked dolphin mating occur in the spring or summer, with calving occurring mainly around 11 months later between May and August (although some may be born in September or October) (Reid *et al.,* 2003). Little is known about the reproductive behaviour of this species and whilst it is thought that births often occur offshore in the northern North Sea (Evans, 1991), there is also evidence to suggest that females move into inshore waters to give birth (Canning *et al*., 2008; Weir *et al*., 2007).

123. The main prey species for white-beaked dolphin in Scottish waters is whiting, but this species also consume other clupeids *Clupeidae* (e.g. herring), gadoids (e.g. haddock and cod) and shad (*Alosa spp*.) (Canning *et al*., 2008; Santos *et al*., 1994). Although the distribution and abundance of prey species affects the distribution and abundance of white-beaked dolphin, this species tends to be influenced by temperature with larger numbers and group sizes associated with cooler temperatures (Evans, 1990; Weir *et al.*, 2007; Canning *et al*., 2008).

124. Due to gaps in knowledge about the ecology of this species, the conservation status of the white-beaked dolphin within North Sea waters is currently unknown (Weir *et al*., 2007). White-beaked dolphin are endemic to the cold temperate water of the northern North Atlantic and whilst there are no reported decreases in the global abundance of this species, there are concerns about the potential impact of climate change causing a reduction in its range (Kinze *et al.,* 1998; MacLeod *et al*., 2005). In general, this species is only found in waters cooler than around 18˚C and is most common in waters below about 13˚C (Tetley *et al.,* 2013).

Distribution and occurrence

125. In the north-east Atlantic white beaked dolphins are generally restricted to shelf waters and prefer waters less than 120 m deep (Tetley *et al.,* 2013). However, Weir (2009) suggested that individuals were encountered in waters around Scotland significantly deeper, with a range from 106.5 m to 134.5 m and with no sightings in waters of less than 70 m. That indicated the preference of white-beaked dolphins to inhabit open waters located outside of the immediate coastal zone. Moreover, other habitat variables, such as slope and seabed aspect, were thought to be important factors in driving occurrence (Tetley *et al.,* 2013). White-beaked dolphins are capable of long-range regional movements, although individuals can also show repeated inter annual site fidelity.

126. During the historic TCE aerial surveys, white-beaked dolphins were encountered in inshore and offshore waters although almost all encounters were recorded offshore (Figure 6.12) (Grellier and Lacey, 2011). Group size ranged from one to six individuals. During historic boat-based surveys, white-beaked dolphins occurred most often in groups: with a mean group size of three and a maximum group size of 15 individuals (Sparling, 2012). White-beaked dolphins were most often seen in the further offshore, easterly region of the site (Figure 6.13), which corroborates findings of Grellier and Lacey (2011). A peak in sightings and therefore density was apparent to the north-east of the survey area.

127. Weir *et al.* (2007) reported that the presence of white-beaked dolphins within the coastal North Sea area in Aberdeenshire is strictly seasonal, as animals were recorded only between June and August, with a peak in occurrence during August.

128. During the DAS, white-beaked dolphins were most often in the south-east of the Proposed Development marine mammal study area (see Figure 3.4 to Figure 3.10 in Annex A). The mean encounter rate for white-beaked dolphin was comparatively low with 0.0007 (95% CI = 0 to 0.0003) animals per km due to their seasonality.

Density/abundance

129. White-beaked dolphins in the UK are considered to have a favourable conservation status (JNCC, 2013). The relevant MU for white-beaked dolphins is the CGNS MU (Figure 6.14) which has an estimated population size of 43,951 animals (CV = 0.22, 95% CI = 28,439 to 67,924; IAMMWG, 2021). It is almost three times higher than the previous estimate of 15,895 animals (CV = 0.48, 95% CI = 9,107 to 27,743; IAMMWG, 2015). The SCANS III estimated abundance for block R (Figure 6.6) was 15,694 white-beaked dolphins (CV=0.48, 95% CI = 3,022 to 33,340), with an estimated density of 0.243 individuals per km^2 (Hammond *et al.,* 2021).

130. The JCP Phase III analysis provided estimated abundances for white-beaked dolphin in 2010 by season for the Firth of Forth area of commercial interest (Figure 6.7). Highest abundance was estimated in the spring months with 1,760 animals (97.5% CI = 620 to 4530) with lower estimates in all other seasons; summer with 720 animals (97.5% CI = 360 to 1840), autumn with 540 animals (97.5% CI = 220 to 1130) and winter with 410 animals (97.5% CI = 170 to 1110) (Paxton *et al.,* 2016*)*. This equated to density estimates between 0.029 individuals per km^2 in winter and 0.124 individuals per km^2 in summer and therefore were lower compared to the mean density estimate for SCANS-III Block R (0.243 animals per km^2) as described previously. Additionally, the study reported predicted abundance of white-beaked dolphins in Firth of Forth as a percentage of the predicted number from CGNS MU, based on estimated for summers 2007 to 2010 as 4.6% (97.5% CI = 0.1 to 5.9). However, as stated by Paxton *et al.* (2016), the abundance estimates produced by the JCP Phase III modelling will be less reliable than those obtained from a well-designed dedicated abundance survey given the assumptions made when standardizing the data and the spatial and temporal patchiness of the data available.

131. Mean density calculated from the historic aerial surveys for white-beaked dolphin was 0.042 (CV=0.311) individuals per km^2 (Grellier and Lacey, 2011). Summer density estimates were calculated to be 0.052 (CV=0.35) individuals per km^2, and winter 0.024 (CV=0.66) individuals per km^2. The density estimates given in this report were not corrected for the availability bias and therefore should be considered as the minimum estimated densities. After correcting for availability, Mackenzie *et al.* (2012) estimated absolute abundance for the survey area (aerial and boat-based) across the survey period as 293 (95% CI = 267 to 1055). An availability bias correction for white-beaked dolphin was unavailable, therefore, this study applied a value for bottlenose dolphin (0.11; Mackenzie *et al.,* 2012). Absolute density estimates also had high uncertainty associated with them and ranged from zero to one individual per km^2 in a single grid cell over the survey period.

132. Mean monthly density of white-beaked dolphin estimated from the Proposed Development aerial digital data was 0.009 (95% CI = 0.003 to 0.017) animals per km^2. Correcting this for availability bias based on a bio-logging study in Iceland (Rasmussen *et al.,* 2013) gave an absolute density of 0.05 (CV = 1.40, 95% CI = 0.017 to 0.094) animals per km^2 and was therefore similar to the minimum summer density estimates provided by Grellier and Lacey (2011).

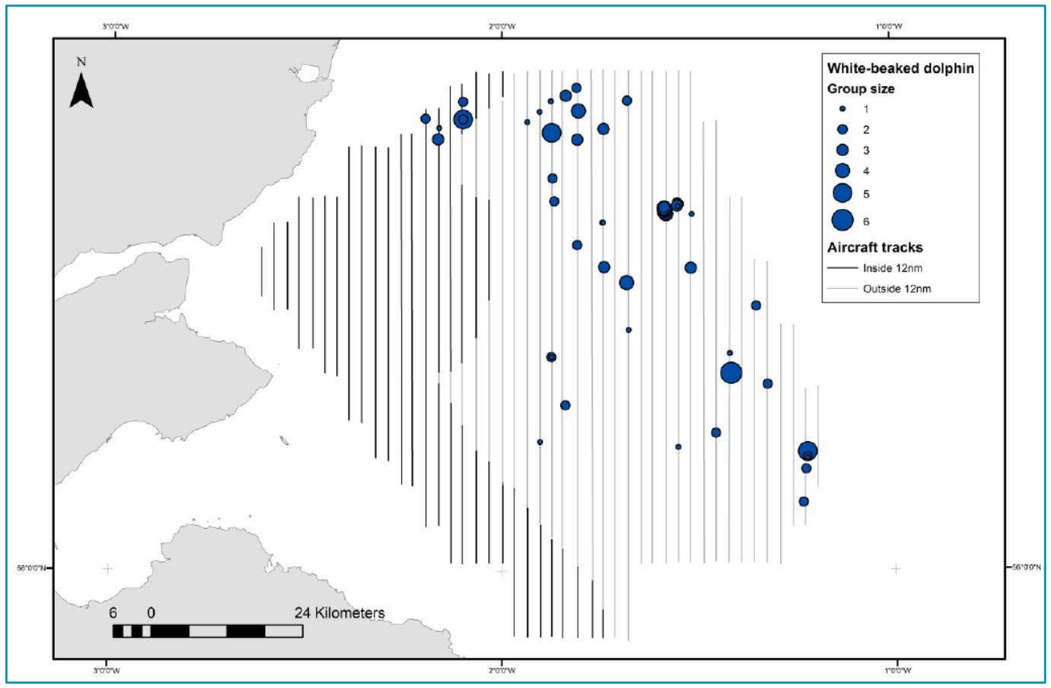

Figure 6.12: White-Beaked Dolphins Distribution and Group Size During Historical Aerial Surveys Across All Seasons from May 2009 to March 2010, Source: Grellier and Lacey (2011)

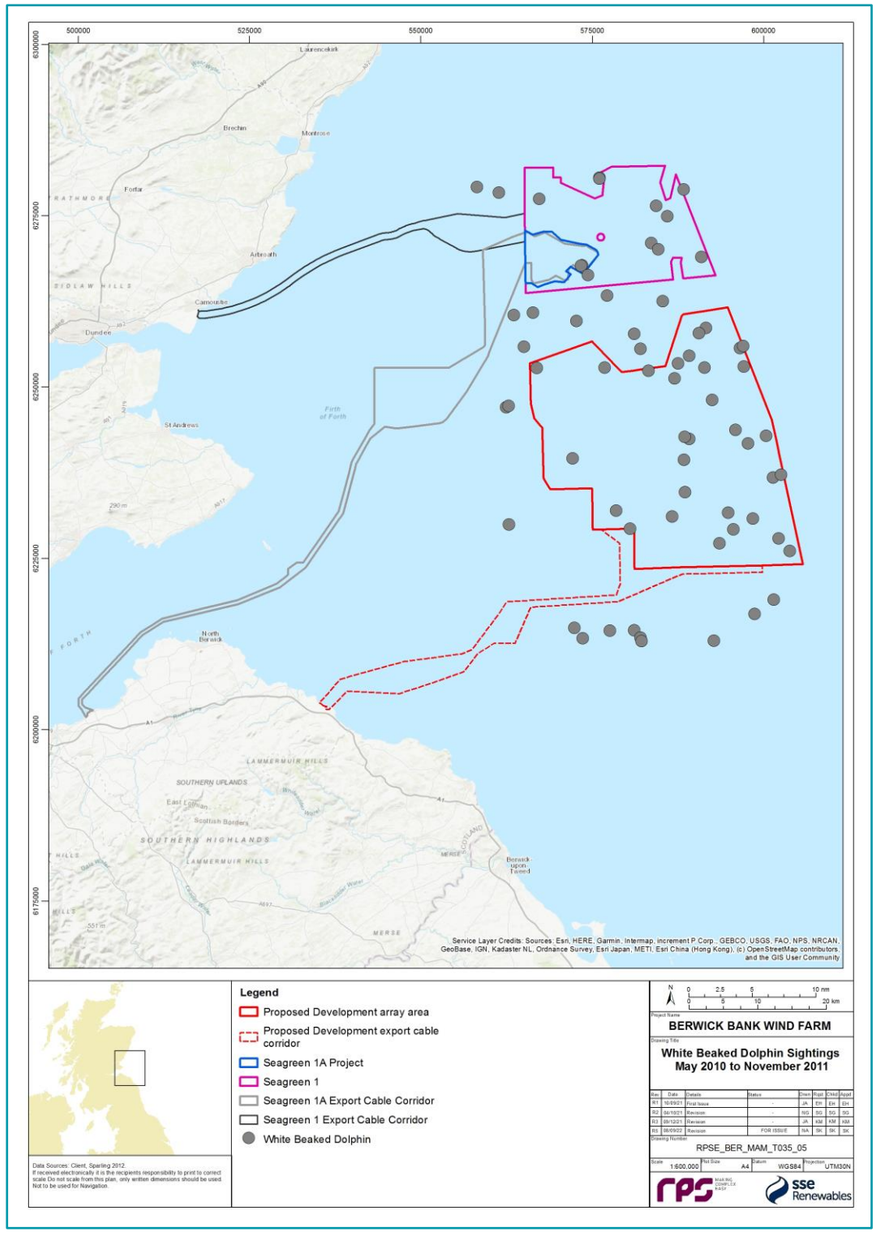

Figure 6.13: Positions of White-Beaked Dolphin Sightings Across All Seasons During Firth of Forth Round 3 Boat Based Surveys from May 2010 to November 2011 (Sparling, 2012)

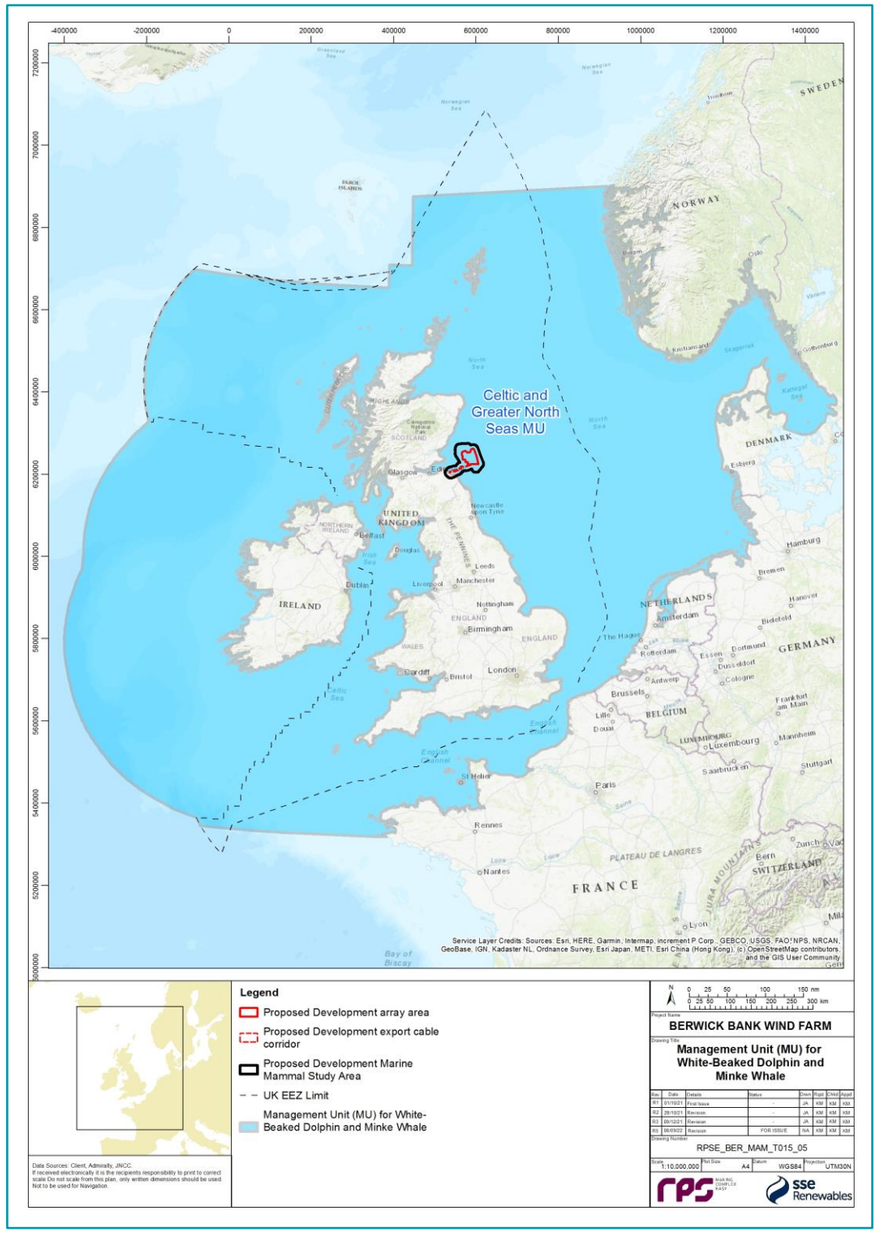

Figure 6.14: Management Unit (MU) for White-Beaked Dolphin and Minke Whale

Seasonality

133. During the historic TCE aerial surveys sightings of white-beaked dolphins were more common in summer (0.0061 sightings per km) than in winter (0.0015 sightings per km) (Grellier and Lacey, 2011). These results were corroborated by historic boat-based surveys, where the highest rates of white-beaked dolphins were seen in the summer months, although low numbers were also seen during surveys in September/October/December 2010 and January 2011 (Sparling, 2012). This seasonal peak is in line with a previous study that also found white-beaked dolphin to be present in Aberdeenshire waters during June to August with the main peak in August (Weir *et al.*, 2007). The Seagreen boat-based surveys in summer 2017 recorded white-beaked dolphins on two of the five surveys: two animals were sighted on the 20 and 21 June 2017 and 17 animals on the 25 and 26 July 2017. A single dolphin of unidentified species was sighted on the 9 and 10 May, the 25 and 26 July and 15 and 16 August 2017 (Seagreen, 2018).

134. White-beaked dolphin sightings were recorded during the DAS during summer months only, between June and September each year, with peak sightings in September 2020, which is in line with historic survey results presented above.

135. The mating season for white beaked dolphin is in July and August with the gestation period lasting about 11 months (Culik, 2010).

6.1.4. MINKE WHALE

Ecology

136. Minke whale is the most frequently sighted mysticete (baleen whale) species in UK waters and is particularly common around the Northern Isles and in regions of the North Sea (Weir, 2001). Minke whales typically live up to 60 years with male minke whales reaching sexually maturity at the age of five to eight years and females at the age of six to eight years. In the northern hemisphere, mating occurs between October to March and the gestation period lasts approximately ten months, with the peak birth period between December and January (Seawatch Foundation, 2012). Calves usually nurse for a period of four to six months.

137. This species tends to be observed either solitarily or in pairs or threes. However, in higher latitudes, including Northern Scotland, larger groups of ten to 15 individuals can be observed, particularly in areas of high prey density (Anderwald and Evans, 2007). Mostly inhabiting continental shelf waters, this species occurs in depths of less than 200 m and can often be seen close to land. This species is often known to exploit prey resources through other species that herd prey, enabling a low energy foraging strategy. Some regional differences exist with respect to diet (Robinson *et al.,* 2007). Minke whale follow prey distribution and sandeel are the key food resource throughout the North Sea, with sprat, shad and herring also preferred prey items (Robinson and Tetley, 2005). Samples taken from the stomach contents of specimens within the North Sea determined that in UK waters the dominant prey items were sandeels, followed by clupeids *Clupeidae* and to a lesser extent mackerel *Scomber scombrus* (Robinson *et al.,* 2007). Around Scotland (including Moray Firth) the primary constituent (70% of the diet of minke whales was the sandeel (Tetley *et al.,* 2008).

Distribution and occurrence

138. In UK waters, minke whales are distributed mainly around Scotland and in the northern and central North Sea reaching south to the Yorkshire coast (Robinson *et al.,* 2007). By far the most sightings within continental shelf waters occur between May and September, with peak numbers from July to September, depending on the region (Evans *et al*., 2003). There are no obvious latitudinal trends in migration and

distribution based on the Sea Watch database, although sightings in the north and east of Scotland have increased since 1990s (Evans *et al*., 2003), most likely due to an increase in prey availability.

139. Data from boat-based studies carried out between May and October 2001 to 2006 in Moray Firth showed that spatial and temporal distribution of minke whales was highly variable and non-uniform (Robinson *et al.,* 2009). Monthly encounter rates were highly inconsistent from one year to the next, with annual encounter frequencies ranging from 0 to 0.042 individuals per km across the 6-year study period. Robinson *et al.* (2009) highlighted that such variability is common in studies of baleen whales on their feeding grounds. From the GIS analyses, however, over 70% of the whales recorded in the Moray Firth study area occurred in steeply sloped areas at depths of between 20 m and 50 m. The arrival of whales in the study area each year appears to be synchronised with the emergence of sandeels into the water column to feed, and in the GIS results over 66% of the whale encounters showed a clear spatial preference for sandy-gravel sediments (i.e. optimal sandeel habitat (Robinson *et al.,* 2009)). The study proved strong correlation of the sediment type with the distribution of whales.

140. During the historic TCE aerial surveys minke whales were encountered throughout the survey area, with slightly more sightings in the northern part of the survey area (Figure 6.15; Grellier and Lacey, 2011). Sixty-two minke whales were recorded during surveys between 2010 and 2011 with the average encounter rate of 0.003 individuals per km and highest encounter rate in May 2010 with 0.017 individuals per km. Minke whales were mostly recorded as single animals, although three animals were sighted together in May 2010 and two in June 2011.

141. During the DAS, minke whales were recorded throughout the Proposed Development marine mammal study area (see Figure 3.4 to Figure 3.10 in Annex A). However, the mean encounter rate for minke whale was comparatively low with 0.001 (95% CI = 0.0003 to 0.002) animals per km due to their seasonality.

Density/abundance

142. All minke whales in UK waters are considered to be part of the CGNS MU (Figure 6.14). Based on the most up to date estimates, the abundance of minke whales in this MU is 20,118 animals (CV = 0.18, 95% CI = 14,061 to 28,786; IAMMWG, 2021). These values are lower comparing to the previous estimates from IAMMWG (2015) with 23,528 animals (95% CI = 13,989 to 39,572). However, it has been suggested that IAMMWG (2015) abundance estimates are likely to be underestimated due to the SCANS II aerial survey estimate not being corrected for perception bias and the Cetacean Offshore Distribution and Abundance (CODA) estimate not being corrected for either perception or availability bias. The SCANS III estimated abundance for block R (Figure 6.6) was 2,498 minke whales (CV = 0.61, 95% CI = 604 to 6,791) with an estimated density of 0.0387 individuals per km^2 (Hammond *et al*., 2021).

143. The JCP Phase III analyses presented abundances for minke whales in 2010 by season for the Firth of Forth area of commercial interest region (Figure 6.7) estimated highest abundance in the summer months at 360 (97.5% CI = 140 to 990) animals, with low estimates in all other seasons (20 animals during autumn and winter). This equates to density estimates between 0.025 individuals per km^2 and 0.001 individuals per km^2. Additionally, the study reported predicted abundance of minke whales in Firth of Forth as a percentage of the predicted number from CGNS MU, based on estimated for summers 2007 to 2010 as 1.4% (97.5% CI = 0.6 to 2.3). However, as stated by Paxton *et al. (*2016), the abundance estimates produced by the JCP Phase III modelling will be less reliable than those obtained from a well-designed dedicated abundance survey given the assumptions made when standardizing the data and the spatial and temporal patchiness of the data available.

144. Integrated analysis of FTOWDG aerial (Grellier and Lacey, 2011) and Seagreen Firth of Forth Round 3 (Sparling, 2012; Figure 6.15) specific boat-based surveys data was able to generate spatially explicit absolute densities, although these were very low. Absolute abundance across the survey period and area was estimated as 594 but also showed a high level of uncertainty due to the low number of sightings (95% CI = 483 to 2695). An availability bias correction factor applied to this analysis for minke whale was 0.04 (Mackenzie *et al.,* 2012).

145. The greatest number of minke whales counted from the Seagreen boat-based surveys was 13 animals on the 25 and 26 July 2017 where two unidentified whales were also recorded. No minke whales were sighted during the June survey and only one animal per survey was recorded on the 9 and 10 May, 24 and 25 May and 15 and 16 August 2017 (Seagreen, 2018).

146. Mean monthly density of minke whale based on the Proposed Development aerial digital survey data was estimated as 0.007 (95% CI = 0.004 to 0.010) animals per km^2. Correcting this for availability bias using dive profile data from a visual tracking study in Iceland (McGarry *et al.,* 2017), provided an absolute density of 0.016 (95%CI = 0.009 to 0.023) animals per km^2 (section 3.5.3 in Annex A).

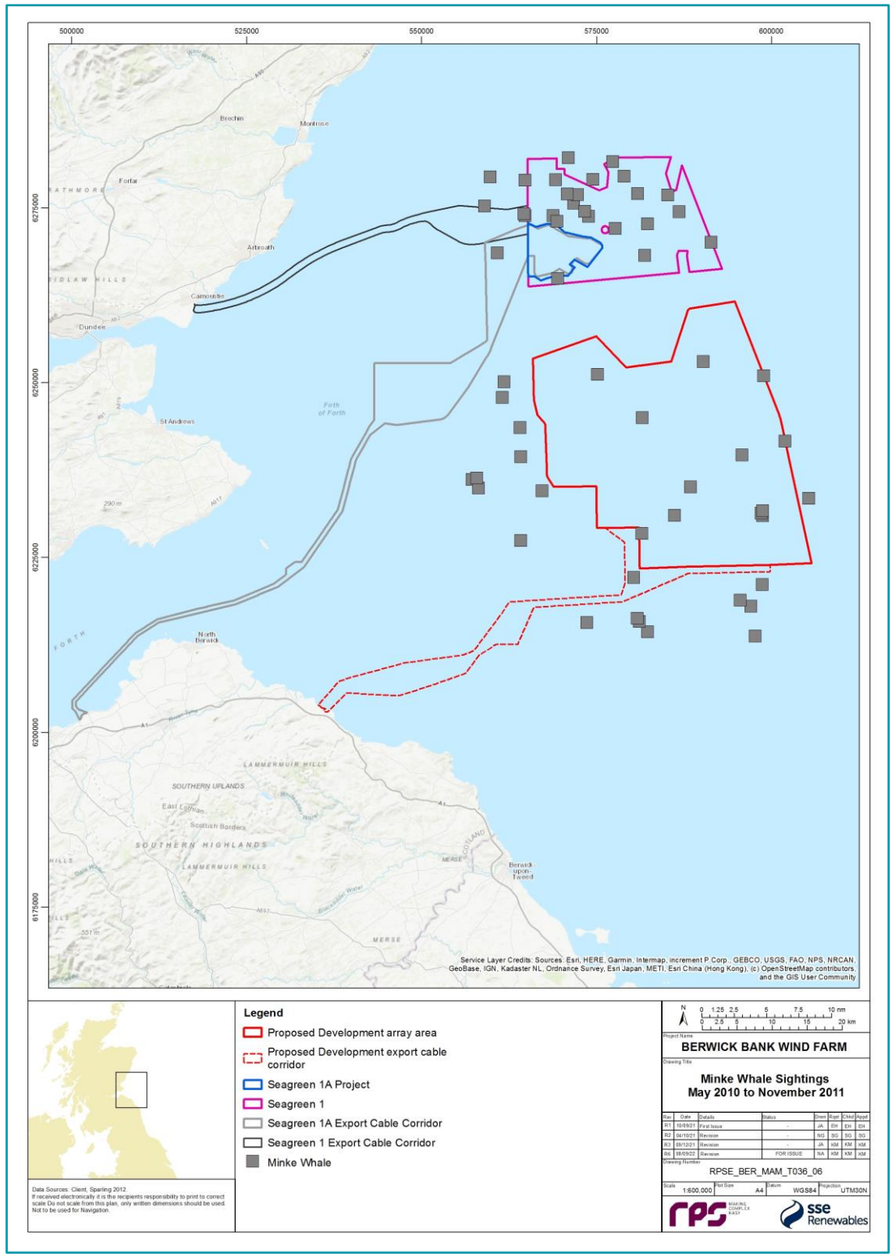

Figure 6.15: Positions of Minke Whale Sightings Across All Seasons During Firth of Forth Round 3 Boat Based Surveys from May 2010 to November 2011 (Sparling, 2012)

Seasonality

147. Boat-based surveys carried out between May and October 2001 to 2006 in Moray Firth reported that minke whales were encountered each month with a peak in annual occurrence from July to August (Robinson *et al.,* 2009). The distribution of whales showed a progressive inshore movement of animals across the summer and autumn months and then a progressive return to offshore waters again towards the end of the study period at which time whales were evidently less abundant, although the timing of this inshore-offshore movement was clearly variable from one year to the next. The results of this study suggest that while sandeels in the Moray Firth are highly targeted by minke whales in summer months, offshore populations of pelagic herring and sprat may also be equally or sometimes even more accessible to foraging whales at certain periods across the summer or from one year to the next, as this would explain the seasonal inshore-offshore movements and inter-annual variability of animals.

148. Rish *et al.* (2019) analysed the presence of minke whale pulse trains by automated detectors developed across ten sites (from southern edge of St. Abbs to northern Moray Firth) from May to November 2016 and at Helmsdale from May 2015 to January 2018. During the study, across the whole array and all years, minke whale pulse trains were first detected in late May and detections generally declined at the end of October. During autumn and spring, minke whale pulse train detections showed strong diel periodicity, with calling rates being lowest during daylight and highest during the night. Diel variation in baleen whale vocalisations has also been attributed to prey distribution, with reduced vocalisation rates during active feeding and an increase in vocalisations in a social context at hours of lowest prey availability (Rish *et al*., 2019). Minke whale main prey items, such as sandeel species, show a strong diurnal pattern and are generally less available in the water column during the night (Rish *et al*., 2019).

149. The observations from historic Firth of Forth Round 3 boat-based surveys conducted between 2010 and 2011 are in line with previous studies of Aberdeenshire coastal waters that reported minke whales to be highly seasonal in occurrence with sightings mainly in the summer months (Sparling, 2012). Encounter rates were highest in the spring and summer and relatively low in autumn and winter. Similar pattern was reflected in the Neart na Gaoithe boat-based surveys between 2009 and 2012 with sightings recorded only between May and November (Neart na Gaoithe, 2018).

150. Minke whale sightings were recorded during DAS between April and September each year with peak sightings in July both years, which is in line with results of studies presented in paragraph 147 *et seq.*

6.2. PINNIPEDS

6.2.1. HARBOUR SEAL

Ecology

151. Harbour seal is the smaller of the two species of pinniped that breed in the UK, typically weighing between 80 to 100 kg (SCOS, 2015). Female harbour seal become sexually mature at three to five years of age and gestation lasts between 10.5 and 11 months (Thompson and Härkönen, 2008). Harbour seal are long-lived animals with individuals estimated to live to between 20 and 30 years (SCOS, 2018).

152. Harbour seals, are central place foragers, requiring haul-out sites on land for resting, moulting and breeding, and dispersing from these sites to forage at sea. In order to reduce time and energy searching for prey, animals are likely to travel directly to areas of previously or predictably high foraging success (Bailey *et al.,* 2014). Harbour seals persist in discrete metapopulations and tend to stay within 50 km of the coast, although most foraging trips are over shorter ranges (Russell and McConnell, 2014). This finding is supported by tagging studies of seals in the UK (SCOS, 2018). Since females need to regularly return

to their pups at the haul-out site they may be more limited in foraging distance. Because of the constraint on their foraging range, particularly during the breeding season, harbour seals may be particularly vulnerable to changes in prey abundance or disturbance events from human activities (Bailey *et al.,* 2014).

153. Harbour seal breed in small groups scattered along the coastline. In north-east Scotland, the Dornoch Firth and Morrich More SAC supports an internationally important population of harbour seal, which utilise sandbars and shore as breeding sites. Pups are born in June and July having moulted their white coats prior to birth. This allows harbour seal pups to swim within a few hours of birth (Burns, 2002). During lactation, females spend much of their time in the water with their pups and, although they will forage during this period, distances travelled at this time are more restricted than during other periods (Thompson *et al*., 1994). Following the spring/summer breeding and nursing season, the annual moult of harbour seals in Scotland occurs from August through September (Thompson *et al.,* 2019).

154. Harbour seal are generalist feeders and their diet varies both seasonally and from region to region (Hammond *et al*., 2001). The analysis of stable isotopic composition and concentration of Hg and Se ions in blood of harbour seals from the North Sea demonstrated that harbour seals diet is comprised of 30% juvenile cod, 29% of plaice *Pleuronectes platessa* and 23% of monkfish *Lophius piscatorius* as well as European hake *Merluccius merluccius* and haddock (Demseaux *et al.,* 2021).

155. Breeding harbour seals are surveyed in June and July in a small number of areas. A very limited number of breeding season surveys have been carried out on behalf of NatureScot in areas designated as SACs for harbour seals in Scottish waters and there were no breeding surveys carried out for the colonies within the Proposed Development marine mammal study area. Therefore, no data was available for haul-out sites considered within this report.

Distribution and occurrence

156. The telemetry data confirmed harbour seal usage within the Proposed Development marine mammal study area. Of the 46 adult harbour seals tagged in East Scotland between 2001 and 2017, 25 had telemetry track data recorded within the Proposed Development marine mammal study area (Figure 6.16). The telemetry tracks were concentrated to the north-west of the Proposed Development marine mammal study area, with comparatively lower numbers of tracks within the east and south-east of the Proposed Development array area or the Proposed Development export cable corridor. All 25 of these harbour seals also showed connectivity with the Firth of Tay and Eden Estuary SAC. Only two of the 25 harbour seals tagged in the East Scotland MU recorded telemetry data out with the East Scotland MU, with both seals recording telemetry tracks within the Northeast England MU. No harbour seals have been tagged in the Northeast England MU. There were also no harbour seal haul-outs recorded within the Proposed Development marine mammal study area.

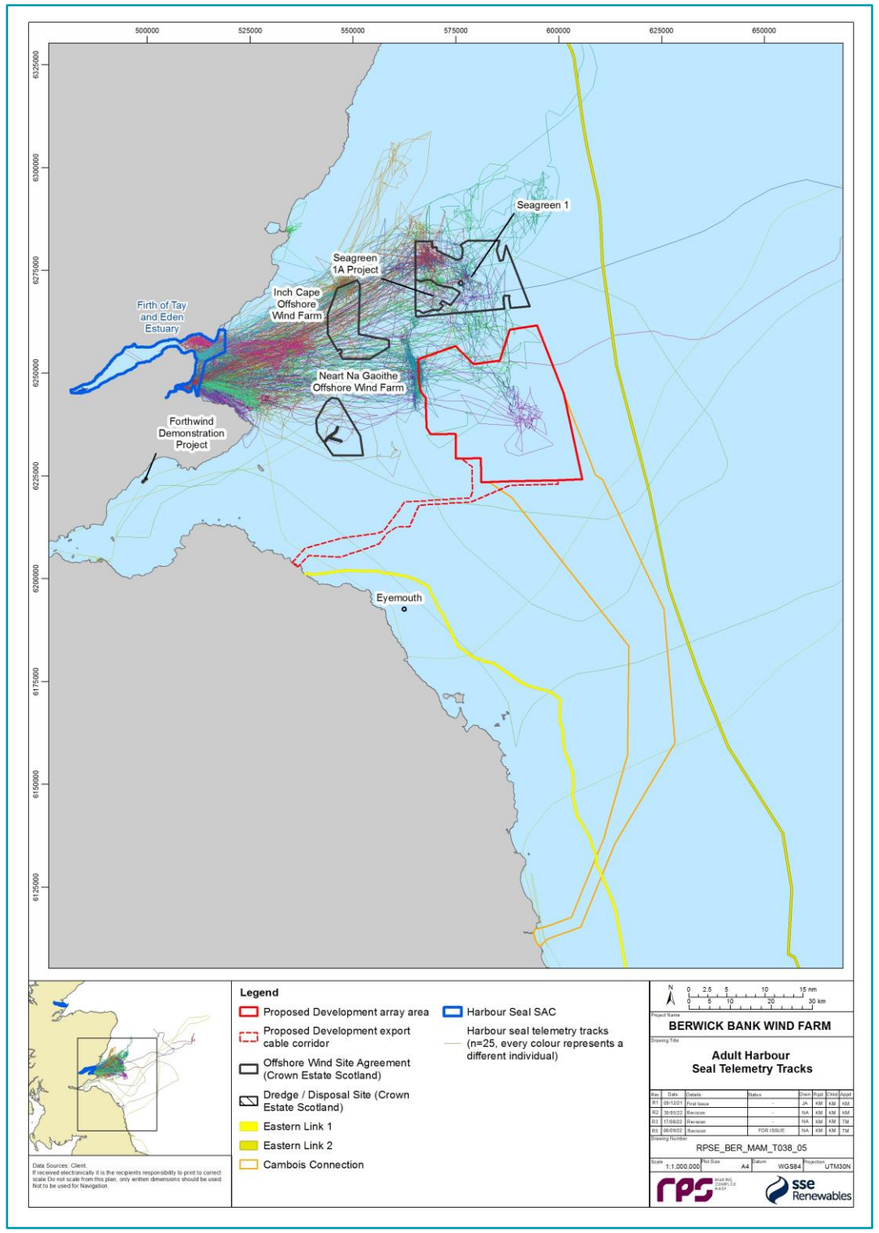

Figure 6.16: Telemetry Tracks for All 25 Harbour Seals that Entered into the Proposed Development Marine Mammal Study Area (Aggregated Data for All Tagged Harbour Seals in the East Scotland MU Between 2001 to 2017)

Density/abundance

157. The Proposed Development is located within the East Scotland and North East England MUs. The nearest designated haul out sites for harbour seals in the MU in the vicinity of the Proposed Development are Kinghorn Rocks and Inchmickery and Cow and Calves (Figure 6.17). The main population surveys are carried out when harbour seals are moulting, during the first three weeks of August. The most recent UK wide harbour seal count presented in SCOS (2020) and Sinclair (2022) collates data collected for the count period 2016 to 2019 (Annex B). This produced a total count for the UK of 31,744 seals, which, scaled to account for the proportion of animals at sea at the time of the count, gave an estimated population size of 44,100 (95% CI = 36,000 to 58,700), of which 84.3% are located in Scotland (37,200 animals, 95% CI = 30,400 to 49,600). Overall, the UK harbour seal population has increased since the late 2000s and is close to the 1990s level. However, there are significant differences in the population dynamics between seal MUs. Populations along the east coast of Scotland have generally declined since the early 2000s as within this MU the current population size is at least 40% below the pre-2002 level. Populations in the Tay and Eden SAC are continuing to decline and although continued declines are not evident in the Moray Firth, there is no indication of recovery (SCOS, 2020).

158. The most recent harbour seal August moult count presented for the East Scotland MU is 343 (2016 to 2019 count period; SCOS, 2020). The population in this MU is mainly concentrated in the Firth of Tay and Eden Estuary SAC and in the Firth of Forth (Figure 6.17). Small groups are also present in the Montrose Basin and at coastal sites in Aberdeenshire. From 2002 to 2017 the harbour seal count for the Firth of Tay and Eden Estuary SAC decreased rapidly at approximately 18.6% p.a. (see Table 3 in Annex B). Subsequently, the count in 2019 for this SAC was 41, which represents a 95% decrease from the mean counts recorded between 1990 and 2002 (SCOS, 2020). The sporadic counts in the Firth of Forth indicate that the decline is localised within the SAC and may not represent the trends in the overall MU population (Figure 6.18). For example, while this MU has shown a large decline in numbers since the 1996 to 1997 count period, the most recent haul-out count in the 2016 to 2019 period (343) was higher than that in the 2011 to 2015 count period (224) suggesting that the MU population overall may be starting to increase in recent years. Haul-out counts can be scaled by the proportion of seals hauled-out at the time of the count and, using the most recent count, resulted in a total East Scotland MU population size estimate of 476 harbour seals (Sinclair, 2022). The count of harbour seals in the East Scotland MU for harbour seal accounts for approximately 1.1% of the total population of Great Britain.

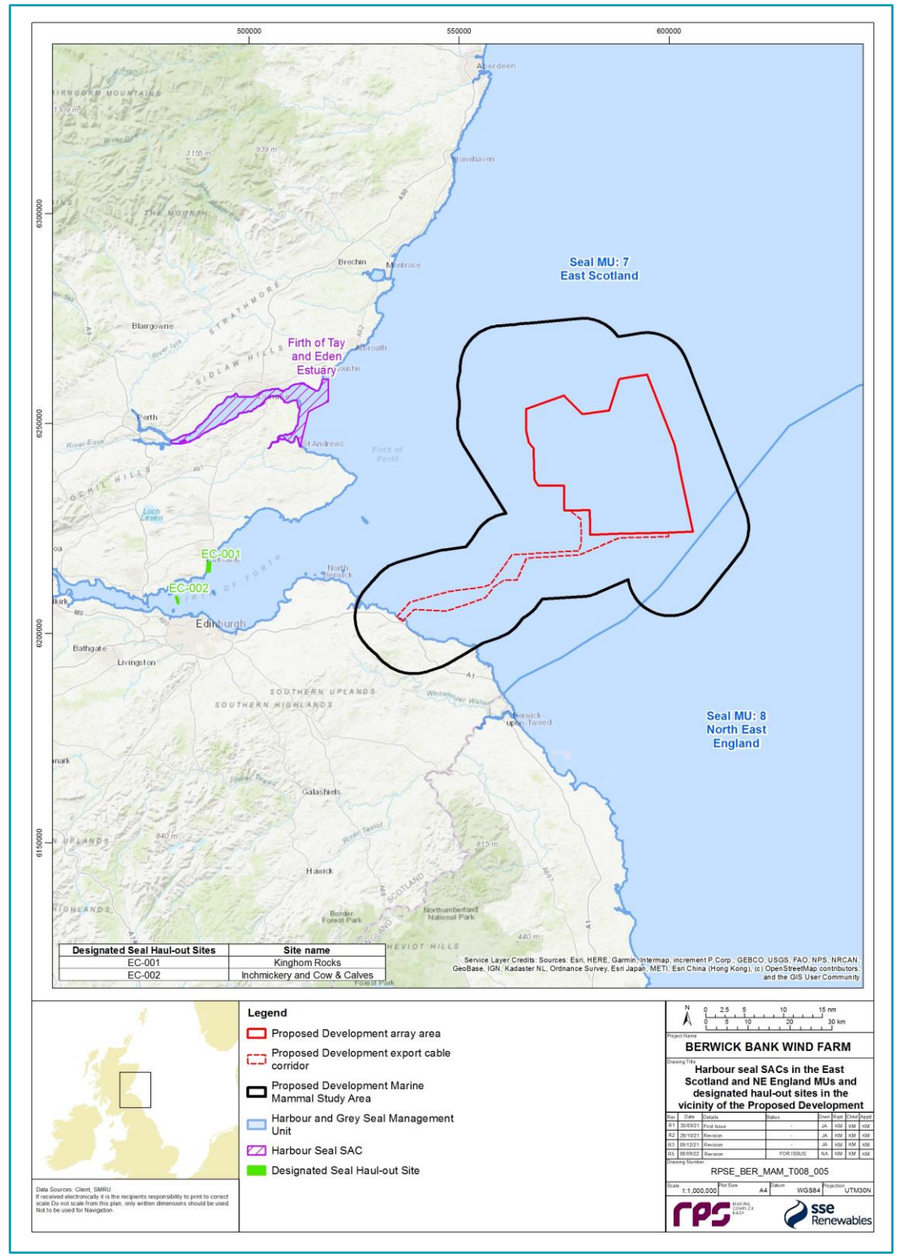

Figure 6.17: Harbour seal SACs in the East Scotland and Northeast England MUs and Designated Haul Out Sites in the Vicinity of the Proposed Development

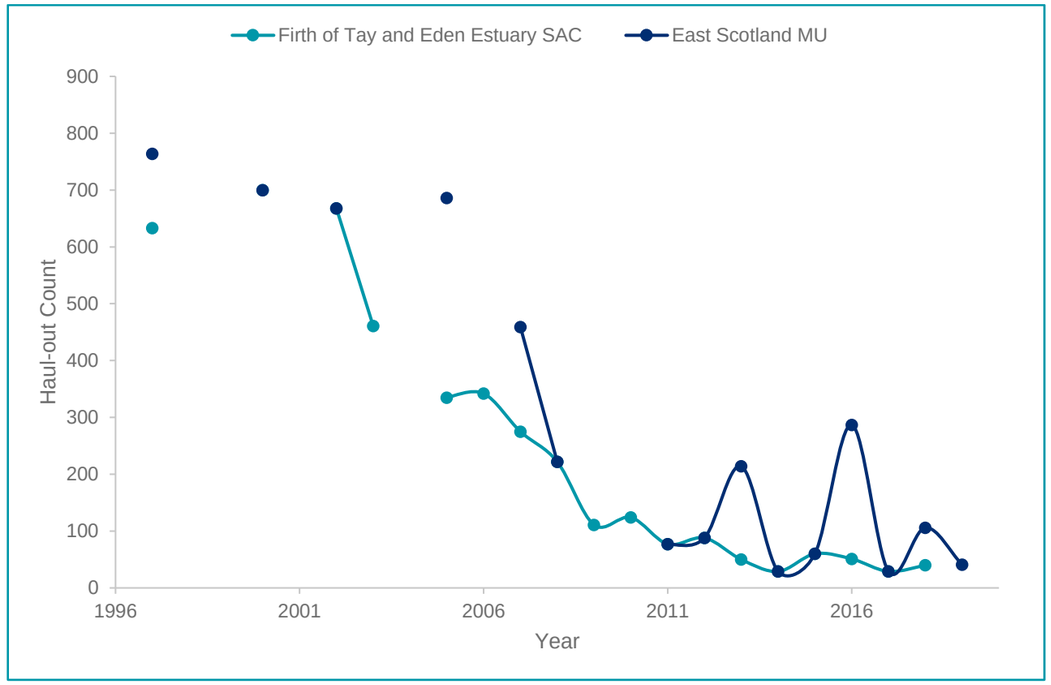

Figure 6.18: August Haul Out Counts of Harbour Seals in the East Scotland MU and the Firth of Tay and Eden Estuary SAC. Source: Sinclair (2022)

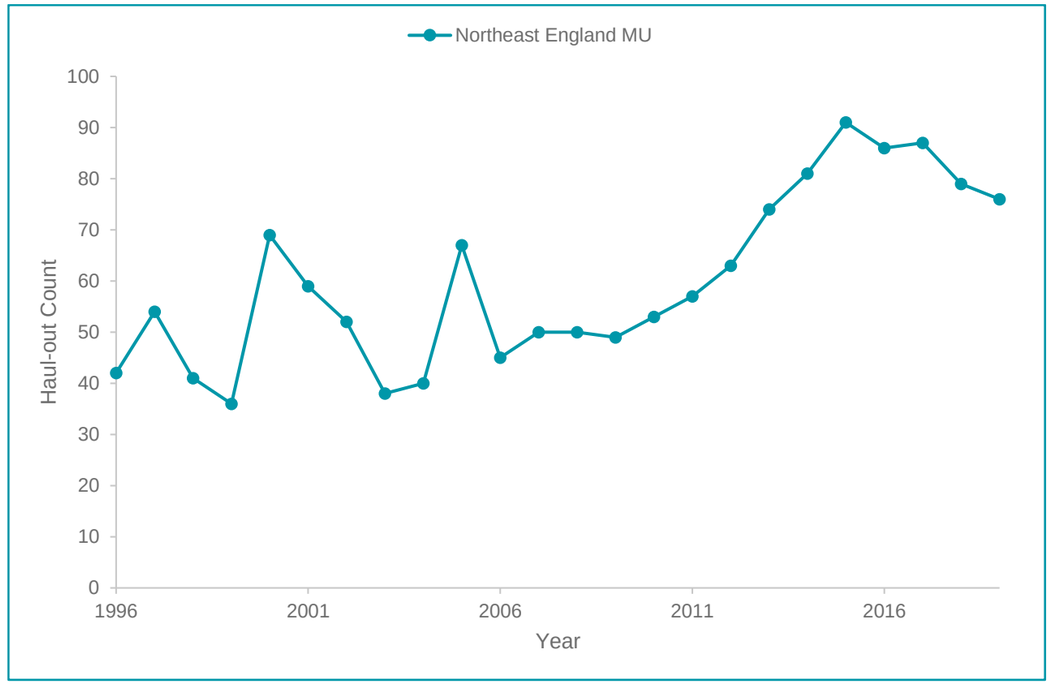

Figure 6.19: Annual August Haul Out Counts of Harbour Seals in the Northeast England MU. Source: Sinclair (2022)

159. Harbour seal August haul-out counts in the Northeast England MU are low, with annual counts ranging between 38 and 91 (Figure 6.19). Harbour seals in the Tees Estuary have been monitored since 1989 and following a slow increase in numbers from an average of 43 between 2003 and 2008, to an average of 88 in 2015 to 2017, both surveys in 2018 and 2019 produced mean August counts of 76 harbour seals (SCOS, 2020). The most recent haul out count of 79 harbour seals for the 2016 to 2019 count period can be scaled by the proportion of seals hauled-out at the time of the count to resulting in a total Northeast England MU population size estimate of around 110 harbour seals (Sinclair, 2022). The count of harbour seals in the Northeast England MU accounts for approximately 0.25% of the total population of the UK.

160. Mean harbour seal at sea usage in the vicinity of the Proposed Development is low, with the main area of usage within the Firth of Forth (Carter *et al.,* 2020; Figure 6.20). Within the Proposed Development array area the average value (of the mean at sea usage) is estimated at 0.003 (95% CI = 0.0002 to 0.039) animals per 5 x 5 km grid cell, equating to a density of 0.0001 (95% CI = 0.000008 to 0.0016) animals per km^2. The peak count of harbour seal within grid cells overlapping the Proposed Development array was 0.05 (95% CI = 0.005 to 0.274) harbour seals, which, assuming uniform density within a grid cell is a density of 0.002 (95% CI = 0.0002 to 0.01) animals per km^2. This peak density aligned with the peak density previously reported by Russell *et al.* (2017) across the Proposed Development array area. A density of 0.0005 (95% CI = 0.00003 to 0.04) animals per km^2 is representative of the mean densities of harbour seal along the offshore export cable route.

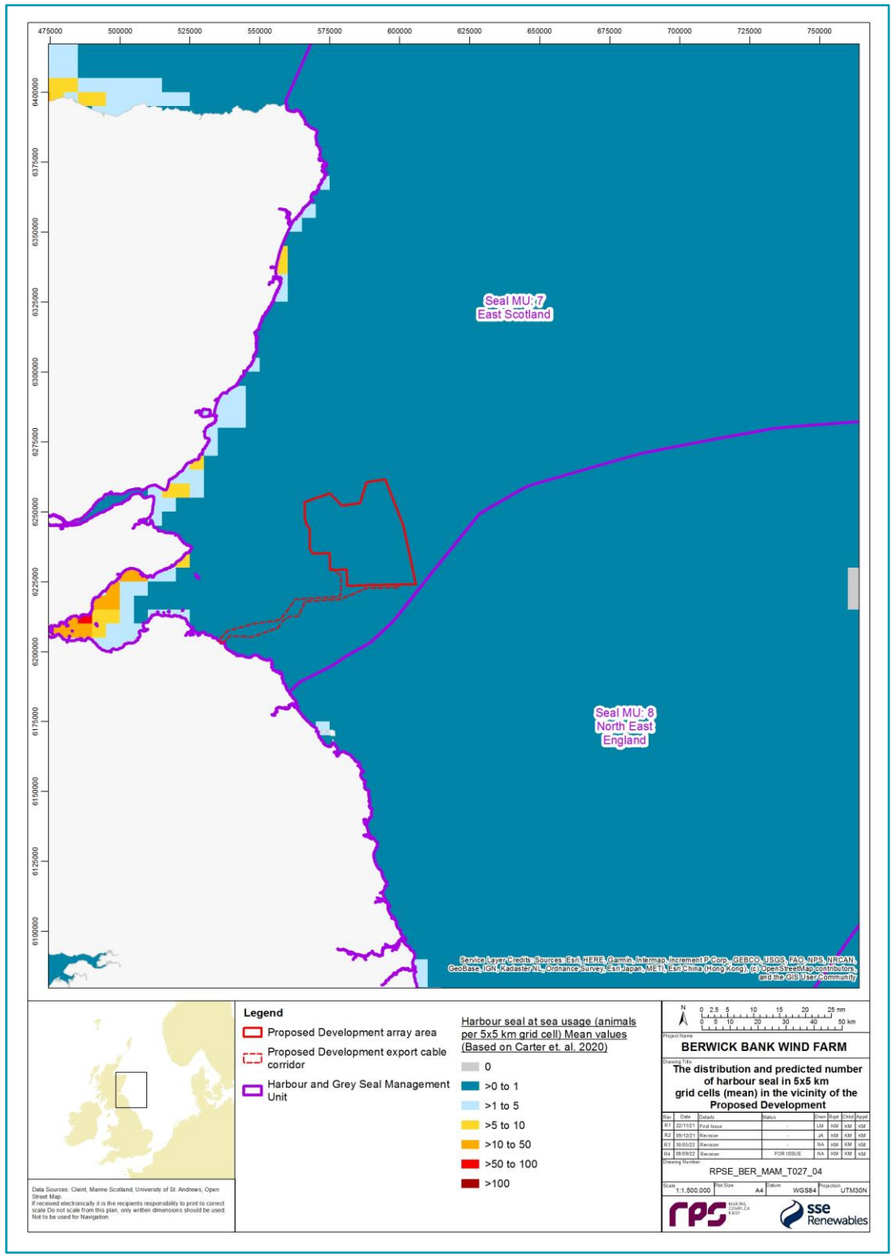

Figure 6.20: The Distribution and Predicted Number of Harbour Seal in 5 km x 5 km Grid Cells (*Mean at Sea Usage*) in the Vicinity of the Proposed Development. Source: Carter *et al.* (2020)

161. Historic boat-based surveys show that harbour seals were seen in low numbers during most months in 2010, with the only exceptions being October and November when no harbour seals were recorded (Sparling, 2012). Harbour seal sightings were lower in 2011 than 2010 and no harbour seals were recorded in February and April to August 2011. Highest encounter rates were in May 2010 and September 2011 at 0.005 individuals per km^2. No harbour seals were recorded during the Seagreen boat-based surveys in 2017 (Seagreen, 2018).

Seasonality

162. A number of seals were recorded during the historic aerial surveys between 2009 and 2010, although majority of them were not identified to species. “All seals” (all seal species sightings grouped together) were distributed across survey area and appeared to be more common offshore in summer (0.0285 sightings per km) than in winter (0.0122 sightings per km) (Grellier and Lacey, 2011).

6.2.2. GREY SEAL

Ecology

163. Grey seal is the larger of the two pinniped species which occur around the British Isles. Males weigh up to 300 kg and female weight is up to 200 kg. Grey seals can live for over 20 to 30 years, with females tending to live longer than males (SCOS, 2015). Sexual maturity is reached at approximately ten years in males and five years in females (SCOS, 2015), and gestation occurs over ten to eleven months.

164. Grey seals gather in colonies on land (known as haul-outs) where they breed, rest, moult and engage in social activity (Bonner, 1990). Russell and Lonergan (2012) reported that haul-out events occur also at sea on exposed sandbanks, but their frequency is low, and their duration is on average shorter than those events on land. Breeding occurs between September to December and the annual moult between November to April (Harwood and Wylie, 1987). Female grey seals tend to return to the same breeding site at which they were born in order to give birth. Preferred breeding locations around the UK coast include rocky shores, beaches, caves, sandbanks and small, largely uninhabited islands. Pupping tends to take place between August and November (SCOS, 2018) in the UK. The largest pupping sites are located in the Inner and Outer Hebrides, Orkney, Isle of May, Farne Islands and Donna Nook (JNCC, 2021d). Grey seal give birth to a single, white-coated pup which are weaned over a period of 17 to 23 days (SCOS, 2018), with the pups leaving the breeding site for the sea after approximately one month. Following this, the female comes into oestrus and mating occurs, after which adult grey seal return to sea to forage and build up fat reserves. Just before weaning the pups shed their white natal coat (lanugo) and develop their first adult coat. Moult occurs in stages at the colony with juvenile seal moulting first, followed by adults.

165. Along the Scottish coast, grey seals exhibit an offshore foraging behaviour (Damseaux *et al.,* 2021). Grey seal have a selective diet, mostly comprised of flatfish and sandeels. A study on the diet of grey seals in Scottish waters found that 50% of prey items were plaice and sole *Solea solea* and 46% of prey items were sandeels (Damseaux *et al.,* 2021). Hammond *et al. (*2001) corroborated this finding and highlighted sandeels as an important prey item for grey seals in Scottish waters where they account for approximately 50% of the diet. Gosch (2017) reported that there are significant regional and temporal differences in the diet of grey seal. Seals in shallow waters show a preference for demersal and groundfish species such as cephalopods and flatfish, whilst seals foraging in deeper waters, over sandy substrates, will target pelagic and bentho pelagic species such as blue whiting *Micromesistius poutassou* and sandeels (Gosch, 2017).

166. Grey seals tend to forage in the open sea, returning to land regularly to haul out. Foraging trips can be wide-ranging, however, tracking studies have shown that most foraging is likely to occur within 100 km of a haul out site (SCOS, 2018).

Distribution and occurrence

167. Globally there are three centres of grey seal abundance: one in eastern Canada and the north-east USA, a second around the coast of the UK, especially in Scottish coastal waters, and a third, smaller group in the Baltic Sea. All populations are known to be increasing (SCOS, 2020).

168. Telemetry data for animals tagged on the east coast of Scotland confirmed grey seal usage of the Proposed Development marine mammal study area (Sinclair, 2022). In total, 46 adult grey seals have been tagged in the East Scotland MU between 1990 and 2013, and a further 23 have been tagged in the Northeast England MU between 1991 and 2008 (Sinclair, 2022). Whilst the focus of this report was on the East Scotland MU and Northeast England MU, all tagged grey seals recorded within these MUs were investigated to determine their origin.

169. Of the 69 adult grey seals tagged on the east coast of Scotland, 59 of these had tracks within the Proposed Development marine mammal study area: 38 originated from East Scotland MU (corresponding to 82.6% of all adults tagged in this MU), 18 originated from the Northeast England MU (corresponding to 78.3% of all adults tagged in this MU) and three were tagged in the north coast and Orkney MU.

170. Grey seals tracks were recorded throughout the Proposed Development marine mammal study area, with a higher density of tracks in the north-west of the Proposed Development array area and a lower density of tracks within the eastern parts of the Proposed Development array area and the Proposed Development export cable corridor (Figure 6.21; Sinclair, 2022). The data showed wide ranging behaviour, with individual grey seals tagged in the East Scotland MU moving as far away as the Outer Hebrides and Denmark (green lines in Figure 6.22).

171. The tagging data illustrated connectivity between the Proposed Development marine mammal study area and SACs. A high proportion of tagged individuals were tracked between the Proposed Development marine mammal study area and the Berwickshire and North Northumberland Coast SAC (73%) and Isle of May SAC (41%) (Sinclair, 2022). Additionally, a very small proportion of tagged seals (2 to 3%) had telemetry tracks within the Faray and Holm of Faray SAC, the Humber Estuary SAC), the North Rona SAC and the Monach Islands SAC. Given that these last four SACs are located at further distances from the Proposed Development marine mammal study area, there are lower levels of expected connectivity between these SACs and the Proposed Development.

172. The movement data was also obtained from the telemetry tags on 38 pup and juveniles, with the majority (~97%) tagged within the East of Scotland MU. It is important to note that pup and juvenile movements may not be representative of the typical movement patterns of adult grey seals, since recently weaned pups are known to disperse widely to haul-out locations far from their birth colony location (Sinclair, 2022). Telemetry track data from the tagged animals showed wide ranging behaviour, with some animals moving into Norwegian and Dutch waters (Figure 6.22). As with the tagged adult grey seals, there was also connectivity demonstrated between the Proposed Development marine mammal study area and SACs for pups/juveniles. Tracks were recorded between the Proposed Development marine mammal study area and the Berwickshire and Northumberland Coast SAC, Isle of May SAC and a small number (5% of tagged animals) within the Humber Estuary SAC.

173. Historic Seagreen Firth of Forth Round 3 boat-based surveys (2010 – 2011) recorded highest numbers of grey seals over sandy shallow banks such as Scalp Bank, Marr Bank, Wee Bankie and Berwick Bank, which are thought to be important areas for sandeels, a key prey item of grey seal (Sparling, 2012).

174. During the DAS grey seals were recorded throughout the Proposed Development marine mammal study area (see Figure 3.4 to Figure 3.10 in Annex A). Assuming that all seal species were grey seal (see paragraph 21 in Annex A) the mean encounter rate was 0.011 animals per km (95% CI = 0.014 to 0.007) (Figure 6.23).

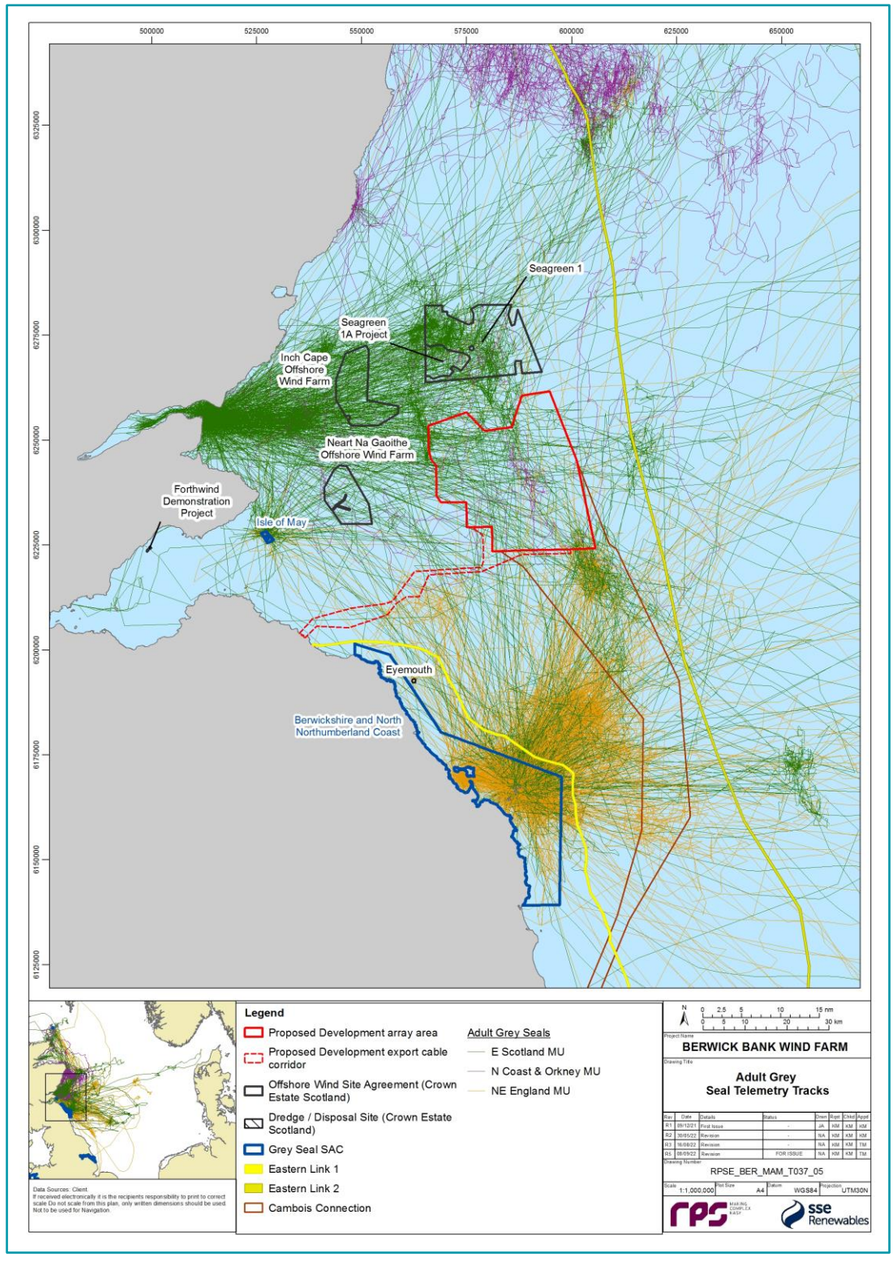

Figure 6.21: Telemetry Tracks for All 59 Adult Grey Seals that Entered into the Proposed Development Marine Mammal Study Area (Coloured by the MU Tagged In)

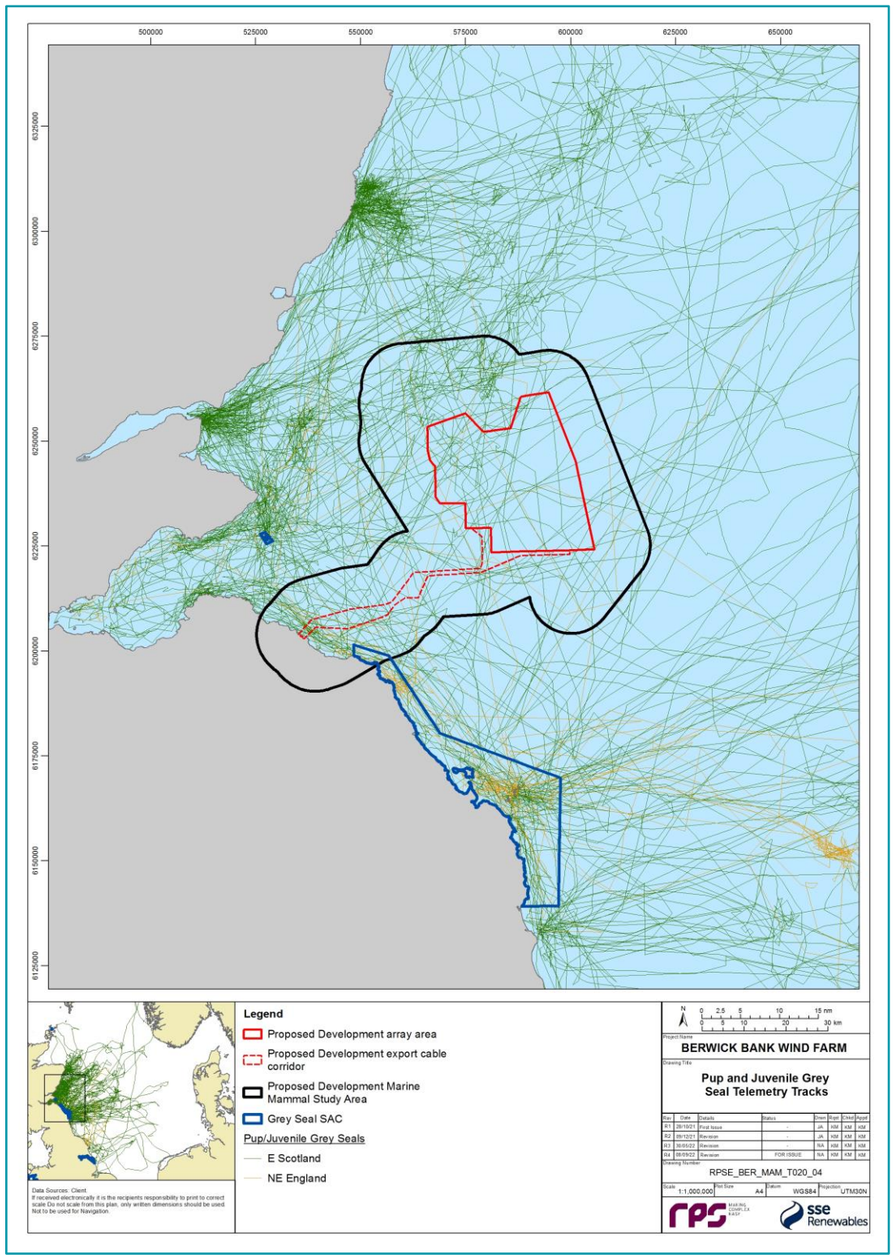

Figure 6.22: Telemetry Tracks for all 38 Pup/Juvenile Grey Seals that Entered into the Proposed Development Marine Mammal Study Area (Coloured by the MU Tagged In)

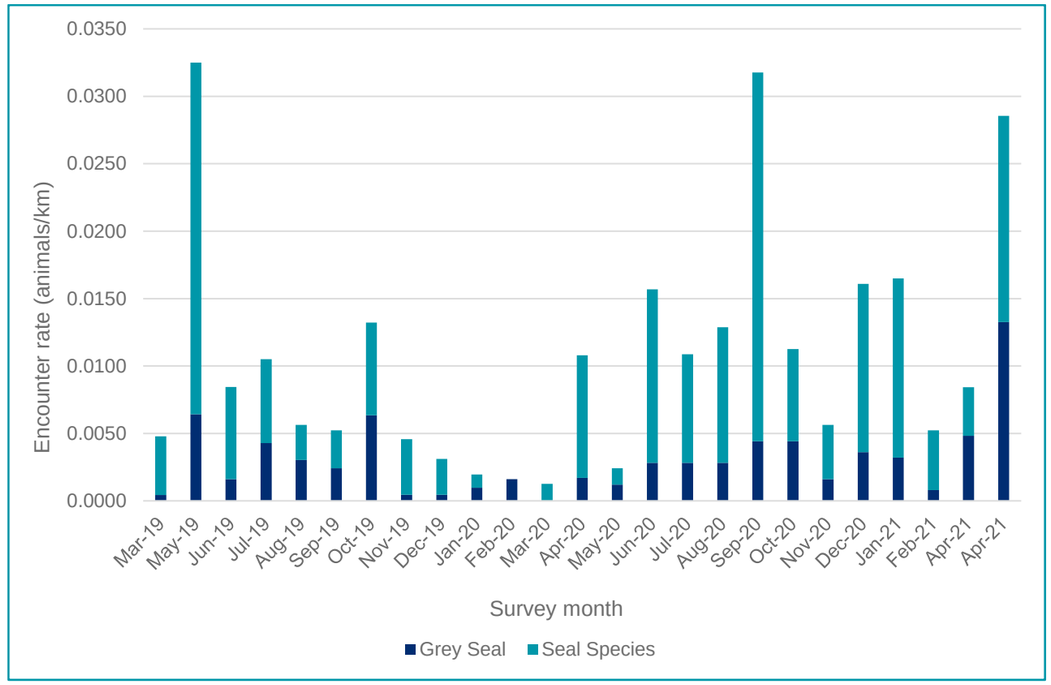

Figure 6.23: Monthly Encounter Rate of Grey Seal Including Seal Species

Density/abundance

175. The nearest designated haul-out sites for grey seals in the vicinity of the Proposed Development are Kinghorn Rocks and Inchmickery and Cow and Calves (for August survey counts) and Fast Castle, Inchkeith and Craigleith for breeding colonies (Figure 6.24).

176. The grey seal is considered to have a Favourable Conservation Status in the UK (JNCC, 2018). Since grey seals are counted during the harbour seal August moult surveys, their numbers may be highly variable, such that these surveys provide information on the summer distribution and abundance of grey seals and may not be an accurate reflection of the total population size. The most recent UK wide grey seal haul-out count presented in SCOS (2020) collated data collected between 2016 and 2019. This produced a total count for the UK of 42,765 seals, which, scaled to account for the proportion of animals at sea at the time of the count, gives an estimated population size of approximately 179,000 individuals. The most recent haul-out count for the whole Scotland for the same period reported a total of 25,412 grey seals (Sinclair, 2022) giving an estimated population of approximately 106,300 grey seals in Scotland.

177. Mean grey seal at sea usage in the vicinity of the Proposed Development is variable, with the hot spots at Berwickshire and Northumberland Coast SAC, Firth of Forth, Tay and Eden Estuary and North of Aberdeen (Figure 6.25; Carter *et al.,* 2020). Carter *et al.* (2020) used the most up-to-date SMRU telemetry data and habitat preference models to estimate at-sea seal usage and, as agreed through consultation with the stakeholders (Table 3.1), these data are deemed most appropriate for grey seal surface density

calculations. Within the Proposed Development array area the average value (of the mean at sea usage) within grid cells was estimated at 30.3 (95% CI = 15.9 to 43.1) animals per 5 x 5 km grid cell, equating to a density of 1.2 (95% CI = 0.64 to 1.7) animals per km^2. This density value is higher than reported by Russell *et al.* (2017), where grey seal density across the Proposed Development array area was 0.285 animals per km^2 and therefore the density of 1.2 animals per km^2 will be carried forward as a maximum grey seal density (Table 7.1). Density values within the offshore export cable route are generally lower than those estimated for the Proposed Development array area. There is, however, a single cell overlapping the Proposed Development export cable corridor closest to the shore with an estimated density of 108.87 (95% CI = 46.5 to 188.6) grey seals per 5 x 5 km grid cell, equating to 4.35 (95% CI = 1.9 to 7.5) grey seals per km^2.

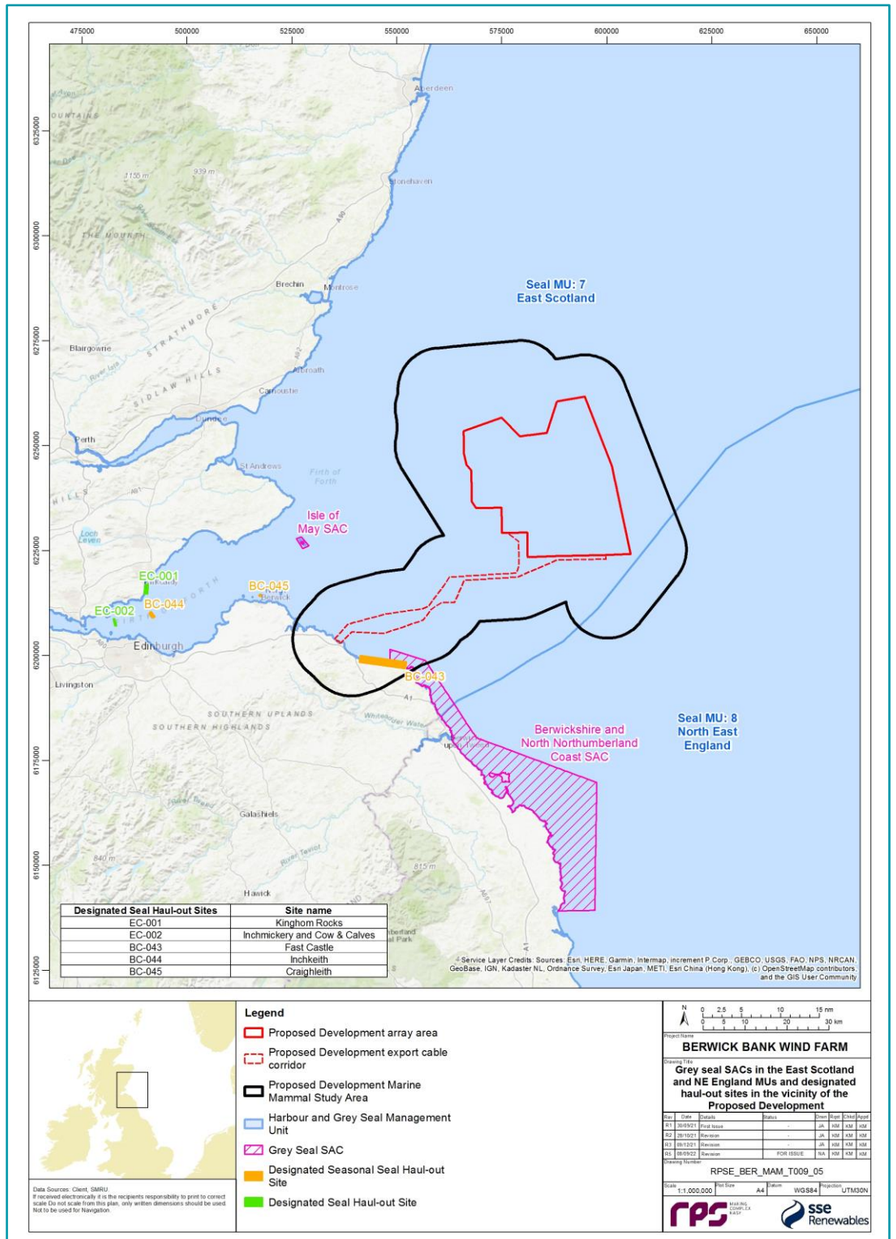

Figure 6.24: Grey Seal SACs in the East Scotland and North-East England MUs and Designated Haul-Out Sites in the Vicinity of the Proposed Development

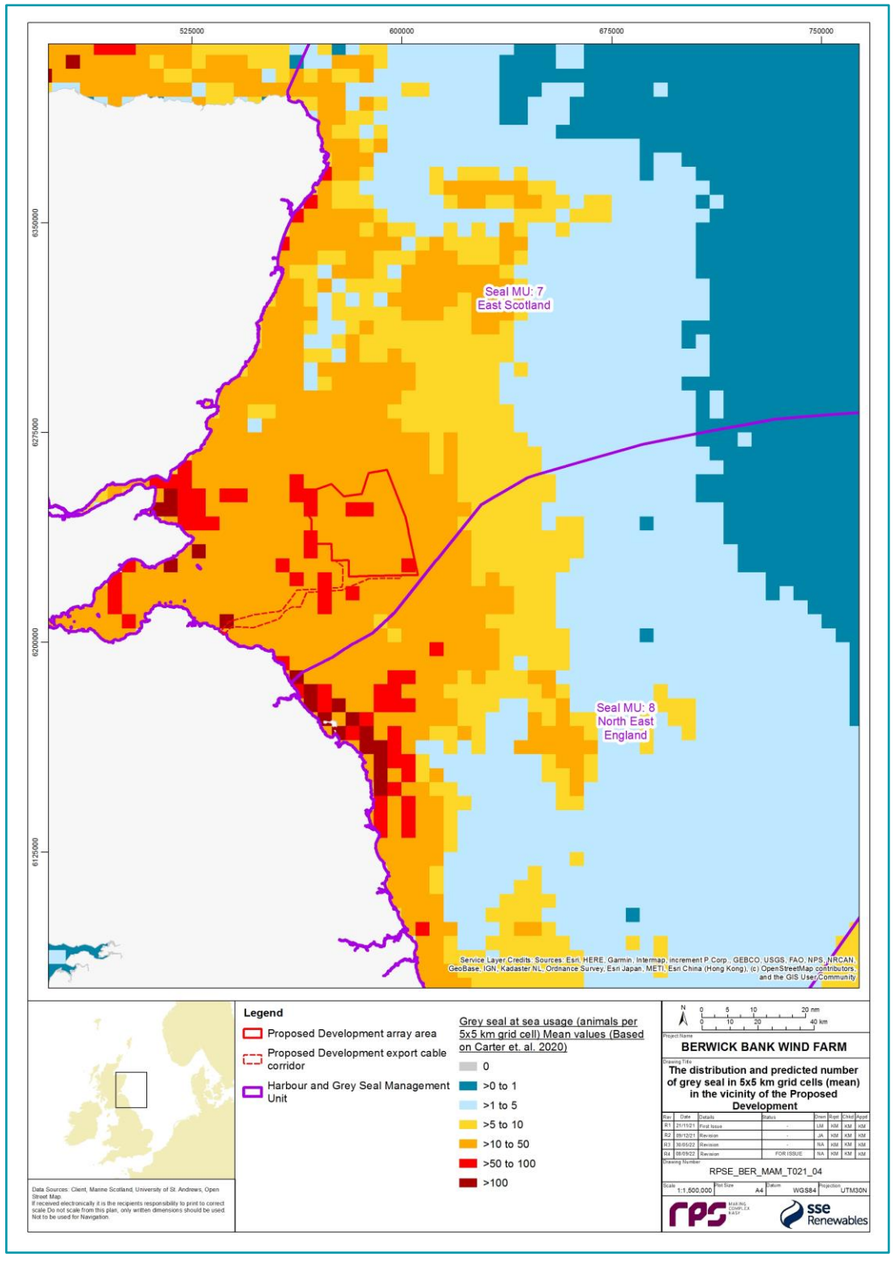

Figure 6.25: The Distribution and Predicted Number of Grey Seal in 5 km x 5 km Grid Cells (Mean) in the Vicinity of the Proposed Development. Source: Carter *et al.* (2020)

178. Grey seal in the Firth of Tay and Eden Estuary is counted almost annually (during the harbour seal August moult counts) with highly variable results ranging between the lowest count of 450 in 2009 and the highest count of 2,253 in 2000 (SCOS, 2020). The latest available count for the whole SAC is 686 individuals in 2019. Overall counts for the East Scotland MU have shown an increase in grey seals from 2,328 in the 1996 to 1997 period to 3,683 between 2016 and 2019 (Sinclair, 2022). If scaled to the proportion of the population at sea at the time of the survey, a population estimate within the East Scotland MU is approximately 15,400 grey seals (Sinclair, 2022).

179. In the Northeast England MU, grey seals are primarily present in the Northumberland area. There has been a significant increase in counts from 603 grey seals in 1996 to1997 to 6,501 between 2016 and 2019 (SCOS, 2020). Comparatively, counts in the Tees which are surveyed annually, have remained low and stable, ranging from 10 in 1995 to 14 in 2019. The total August haul out count of grey seals in the Northeast England MU in the count period 2016 to 2019 was 6,501 grey seals, which accounted for approximately 15% of the grey seals hauled-out in Britain between 2016 and 2019. If scaled to the proportion of the population at sea at the time of the survey, a population estimate within the Northeast England MU is approximately 27,200 grey seals (Sinclair, 2022).

180. There are four haul out sites within the Proposed Development marine mammal study area where grey seals have been counted during August haul out count surveys (though numbers were low at these sites): Long Craigs (Dunbar), Scart Rock (Dunbar), Black Bull (by Fast Castle, St Abbs) and Fast Castle (St Abbs). These sites are all approximately 6 km to 12 km from the boundary of the Proposed Development export cable corridor.

181. Grey seals aggregate in the autumn to breed at traditional colonies between August and December. Their distribution during the breeding season is very different to their distribution at other times of the year. Therefore, the main grey seal surveys are conducted late autumn, when females congregate on land to give birth, to estimate the number of pups born at the main breeding colonies around the UK.

182. There has been a continual increase in the total UK pup production since regular surveys began in the 1960s (SCOS, 2020). There are five grey seal breeding sites in the East Scotland MU, all located within the Firth of Forth region (Craigleith, Fast Castle, Inchcolm, Inchkeith and the Isle of May) (Figure 6.24). Additionally, there is one grey seal breeding site in the Northeast England MU (the Farne Islands). The pup production counts in this area used to be dominated by the Isle of May and the Farne Islands: however, in recent years the pup counts at Fast Castle have significantly increased such that it now has the largest pup production count in the area (SCOS, 2020).

183. The main Scottish breeding surveys were last flown in 2016 (Inner Hebrides, Outer Hebrides, Orkney) and 2018 (Firth of Forth). The total number of pups estimated to have been born in 2018 in the UK was 68,050 (95% CI = 60,500 – 75,100 pups). Based on this most recent pup count, the adult population size at the start of the 2019 breeding season was estimated to be 149,700 (95% CI = 120,000 – 174,900) (SCOS 2020). For Scotland alone, the pup production was estimated as 55,200 individuals which accounted for 81.1% of the grey seal pups born in the UK (Sinclair, 2022). Pup production estimates were not presented for individual SACs in SCOS reports, however, as advised by NatureScot as a part of the scoping opinion (NatureScot Scoping Opinion for 2020 Berwick Bank (7 October 2020)), the pup production for the Isle of May SAC was predicted based on the Firth of Forth haul-outs and was estimated as 6,894 pups (SCOS, 2020). The pup production count for Berwickshire and North Northumberland Coast SAC was predicted based on the combined estimates from the Firth of Forth (6,894) and the Farne Islands (2,737) accounting for a total of 9,631 pups (SCOS, 2020).

184. The grey seal population in the North Sea has grown almost constantly since the mid-1990s, and approximately 80% of the pups in this region are born within the following SACs: Isle of May SAC, Berwickshire and North Northumberland coast SAC (which is made up of Fast Castle and the Farne Islands), and the Humber Estuary SAC (includes Donna Nook).

185. Seasonal density estimates estimated from the Proposed Development aerial digital survey data highlighted that mean monthly densities of grey seal (including seal species) within the Proposed Development marine mammal study area were highest during spring months. Mean monthly density was estimated as 0.043 (95% CI = 0.024 to 0.083) animals per km^2. Correcting this for availability bias based on telemetry data on tagged seals in the North Sea (Orsted, 2018; Thompson *et al.,* 1991) gave an absolute mean monthly density of 0.276 (95% CI = 0.154 to 0.532) animals per km^2 with a peak mean density during spring months of 0.321 (95% CI = 0.179 to 0.603) (Table 6.4). These densities are comparable with the estimated mean at-sea density of grey seal predicted from the SMRU data (Russell *et al.,* 2017) of 0.285 animals per km^2 across the Proposed Development array area, however, are lower than mean value of 1.2 animals per km^2 reported by Carter *et al.* (2020). Therefore, the range of densities carried forward for grey seal in the marine mammal study area was 0.276 to 1.2 animals per km^2 (Table 7.1). Corrected mean abundance of grey seal within the Proposed Development marine mammal study area ranged between 938 animals in winter and 1,605 animals in spring months Table 6.4.

Table 6.4: Grey Seal Plus Seal Species Modelled Absolute Density Estimates by Season for Proposed Development Including LCI and UCI. Abundance Estimates Are Scaled Up to the Proposed Development Plus ~16 km Buffer

Season	Mean Absolute Abundance	Mean Absolute Density (Animals per km^2)	LCI	UCI
Winter	938	0.186	0.083	0.474
Spring	1605	0.321	0.179	0.603
Summer	1448	0.288	0.167	0.526
Autumn	1524	0.308	0.192	0.526
All months	**-**	**0.276**	**0.154**	**0.532**

Seasonality

186. Grey seal sighting rates during historic boat-based surveys (2010 to 2011) were lowest over the autumn and winter. Given that grey seals aggregate in the autumn to breed at traditional colonies between August and December, during these months the number of seals might be expected to be low as a large proportion of the population will be hauled out to breed (Sparling, 2012). Encounter rates of grey seals at sea peaked during June in both years – this is likely to be related to the capital breeding habit of grey seals and possibly indicative of a period of intense foraging where adult seals are at-sea gaining energy reserves prior to the breeding season.

187. The Seagreen boat-based surveys recorded grey seals on every trip. Numbers of grey seals recorded was highest, 45 animals in early summer (9 and 10 May 2017) and lowest in late summer, 15 animals (15 and 16 August 2017). Mid-summer surveys recorded 22 animals (24 and 25 May 2017), 25 animals (20 and 21 June 2017) and 20 animals (25 and 26 July 2017) (Seagreen, 2018).

188. During the DAS grey seals were recorded within the Proposed Development array area every month except March 2020 with a sightings peak in April 2020.

7. SUMMARY

189. Data gathered through a desk-top review and DAS found that the northern North Sea supports a number of different marine mammal species with internationally important populations of certain species occurring within the vicinity of the Proposed Development. Key marine mammals identified within the Regional and Proposed Development marine mammal study areas included: harbour porpoise, bottlenose dolphin, minke whale, white-beaked dolphin, grey seal and harbour seal. Where possible, mean monthly density estimates were generated for this species using site-specific data (from DAS) gathered during monthly aerial digital surveys across the Proposed Development array area plus ~16 km buffer. Where it was not possible to estimate densities due to low sightings rates, data were sought from published sources including regional studies of key species. As agreed with consultees, coastal bottlenose dolphin densities are based on most up-to-date abundances estimated by Arso Civil *et al.* (2021) and probability of occurrence model from Arso Civil *et al.* (2019). A summary of the mean densities for each species are provided in Table 7.1.

190. In accordance with advice received during consultation where population-level effects were considered for a given species-impact pathway, these were informed by species MUs. The IAMMWG provided advice on cetacean MUs (IAMMWG, 2021) and the SCOS (SCOS, 2021) provided advice on seal MUs (Table 7.1).

191. Sites designated for the conservation of internationally important populations in proximity to the Proposed Development marine mammal study area included the Firth of Tay and Eden Estuary SAC designated for harbour seal and the Berwickshire and North Northumberland Coast SAC and Isle of May SAC designated for grey seal. The east coast of Scotland bottlenose dolphin population has connectivity with the Moray Firth SAC 167 km to the north of the Proposed Development array area. Further afield, within the regional marine mammal study area, there were a number of sites designated for internationally important populations of harbour porpoise with the closest being the Southern North Sea SAC at 146 km from the Proposed Development array area.

Table 7.1: Summary of Marine Mammal Receptors to be Considered in the Marine Mammal EIA Offshore Report Chapter Together with Relevant Densities and Reference Populations

Species	Density (Animals per km^2)	Management Unit	Population in MU	SCANS-III Block R (Hammond *et al*., 2021)
Harbour porpoise *Phocoena phocoena*	0.299 to 0.826[1]	North Sea	346,601 (IAMMWG, 2021)	38,646
Bottlenose dolphin *Tursiops truncatus*	Coastal: 0.197 to 0.294[2]	Coastal East Scotland	224 (Arso Civil *et al.,* 2021)	-
	Offshore: 0.0298[3]	-	-	1,924
White-beaked dolphins *Lagenorhynchus albirostris*	0.243[3]	Celtic and Greater North Seas	43,951 (IAMMWG, 2021)	15,694
Minke whale *Balaenoptera acutorostrata*	0.0387[3]	Celtic and Greater North Seas	20,118 (IAMMWG, 2021)	2,498
Harbour seal *Phoca vitulina*	0.0001 to 0.002[4]	East Scotland plus Northeast England	476 + 110 = 586 (Sinclair, 2022; SCOS, 2020)	N/A
Grey seal *Halichoerus grypus*	0.276 to 1.2[5]	East Scotland and Northeast England	15,400 + 27,200 = 42,600 (Sinclair, 2022; SCOS, 2020)	N/A

[1] Site-specific densities (mean and seasonal peak) estimated from Proposed Development aerial digital survey data (2019 to 2021).

[2] Minimum and maximum densities for the 2 m to 20 m depth contour along the east coast derived from 5-year average from Arso Civil *et al.* (2021) with proportion at the outer Firth of Tay assigned using probability of occurrence (Arso Civil *et al.,* 2019).

[3] SCANS-III (Hammond *et al.*, 2021).

[4] Mean and maximum across the Proposed Development marine mammal study area based on at-sea mean density maps (Carter *et al.,* 2020).

[5] Mean monthly density based on site-specific Proposed Development aerial digital survey data (2019 to 2021) and maximum density based on at-sea mean usage maps (mean, Carter *et al*., 2020) across the Proposed Development marine mammal study area.

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9. ANNEXES

9.1. ANNEX A: MARINE MAMMAL AERIAL SURVEY DATA INTERIM DATA ANALYSES

9.2. ANNEX B: SEAL HAUL-OUT AND TELEMETRY DATA IN RELATION TO THE BERWICK BANK WIND FARM

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